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STREET TREE QUESTION.

REPORT OF THE SPECIAL COMMITTEE APPOINTED BY THE HARTFORD FLORIST CLUB.*

HARTFORD, CONN., February 24, 1903.

To the President and the Members of the Hartford Florist Club:

GENTLEMEN:—Your committee appointed to investigate and report on the existing conditions of the street trees in our city, and if not found satisfactory to offer suggestions for additional treatment, respectfully report as follows:

FIRST—THE TREE AND ITS RELATION TO CITY STREETS, AND ITS VALUE AND REQUIREMENTS.

Beautiful cities without trees are impossible. While the trees in their native forests receive no care from human hands, yet in the environments of a city they must either have human care or become sickly and, long before their time, die. Under such unnatural conditions they must have care to succeed, and care requires labor, and labor costs money. Nothing can be placed along the side of a street, not even a hitching post, but requires care, and ever so much more is that care demanded for a living tree.

Hartford is to-day one of the foremost cities in its development of a useful and extensive park system, and its many tree-arched and shaded trees and avenues entitle it to the name which it is receiving throughout the country of "The beautiful city." We have in our city avenues and streets that are made more than attractive through the graceful arches of elms, like Washington street; yet in that very street, in the aristocratic part of the city, lined with beautiful residences, we find trees suffering under conditions which should not exist, and would be impossible under proper management. In some places there is good management, but next door there may be mismanagement and downright neglect and carelessness. Such undesirable conditions will always exist as long as street trees, although standing within the limit of the highway, are considered and treated as the property of the owners of the adjoining grounds. The property owner looks upon the street trees principally in their relation to his own house and grounds and loses sight of their importance as an ornament to the street.

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* Published by authority of the Committee of the "Hartford Florist Club" on the Street Tree Question. Three members of this committee, Theodore Wirth, Chairman; George A. Parker, and J. Wesson Phelps, are members of our Society.

That municipal ownership alone can remedy such conditions is obvious, and the more the value of street trees, as being beneficial and helpful to the general public and ornamental and useful to the community at large, becomes recognized, the more will the public become convinced that city authorities should control the shade-giving street trees and that they are as essential to the welfare and attractiveness of the city as the roadways and sidewalks are important to its traffic and safety.

The long-prevailing idea that trees will not grow in cities, and that they are an obstruction to traffic and to some extent a nuisance, is fast losing ground, and the new cities will know little of treeless thoroughfares. Even more than that, older cities will not shrink from cost or labor to plant and make trees grow. Until recent times possibility of such a feature was not dreamed of, and barren, monotonous residential streets, and even business streets, will become more attractive through the verdure of their branching trees and more habitable under their shade-giving foliage. Such is the progress of time.

It is, however, wrong to assume that the idea of planting and maintaining trees along highways is only of recent date. On the contrary, there is evidence all over the country to show that the progressive, wideawake and nature-loving individuals have long ago, and at all times, recognized the value of trees, not only for their ornamental and decorative qualities for their home grounds and parks, but also as an essential, attractive and inviting feature of the public thoroughfare. But it seems to be the privilege of the present age, in this country at least, to awaken to the important discovery that street trees should be planted, maintained and controlled by the community and not by individuals.

Let us see what has been accomplished elsewhere in this line of municipal development. Every one has heard of the queen of cities, Paris, and those who have seen the city will admit that of all the special features of attractiveness, artistic and natural beauty, which other European and American cities may offer, Paris, as a whole, is "the city." With all its architectural attraction of public and private buildings, of its many wide avenues and streets alive with the restless, fascinating throng of a busy and pleasure-loving people, of its quays along the river Seine, with its numberless fine bridges, of its many historical palaces and grounds, yet the city would lose, as a whole, a great part of their combined attraction if the systematically planned and uniformly well-kept trees were removed. Paris has over 120,000 trees on its public streets, and they are maintained by the city at a cost of less than a half million francs, which is less than a dollar a tree per year. This is a small amount, considering the perfect manner in which the trees are cared for. They are protected by wire guards from horses and a neat-looking cast-iron grating on a level with the surrounding sidewalk protects the circular space about eight feet in diameter which is left open at the base of each tree. These grates can be removed for loosening the soil, and during the dry season the tree is watered. At intervals of time the soil around the tree is renewed with fresh soil from the open country, or with composted soil. Sickly trees are removed and replaced by healthy ones of the same size, so there is no missing link in the tree-lined avenues. They are pruned symmetrically to the same shape and height, which gives them somewhat an artificial stiff appearance that does not seem out of place with the formal architectural appearance of unbroken lines of buildings.

It seems impossible that all the trees of Paris can be so well taken care of for so small an outlay, but that is explained by the fact that a specially equipped department, not molested nor misused by politics, but managed on sound, practical and economical and business principles, a department furnished with all modern implements, having its own nurseries where the trees are grown to different sizes and expert foresters are employed; and by these means, in Paris, the taxpayers receive the full value of their money spent for trees.

Washington, our capital city, will become the Paris of

America as far as tree-lined and arched avenues and streets are concerned, when the plans are fully developed.

The movement in favor of the planting of trees along highways and on public grounds is steadily gaining all over this country. In some states, among which is Massachusetts, New York, New Jersey, New Hampshire and Ohio, cities which have the power have passed ordinances placing trees under the authority and jurisdiction of the city government, and in other states, cities have acquired similar authority through special acts, or amendments to their charter by the legislature.

In Lawrence, Mass., and Pittsburg, Penn., the park commissioners have the entire care of the trees and the expense is paid from the general park fund.

The state law of New York is that all cities shall have entire control of street trees, but they are not always cared for by the same department. In the cities of New York and Buffalo, the park commissioners set and care for all trees on parkways and boulevards. In Philadelphia the city takes care of the trees on its streets and school grounds. In Springfield and Worcester, Mass., the street trees are under the care of the city forester. In Worcester the city forester is under the direction of the park commission. In New Bedford the street trees are under the care of the board of public works, but the expenses of the same are paid by the abuttors. The Minnesota state law gives park commissioners the right to set street trees and to collect from abuttors the cost of setting. In Baltimore an abuttor can petition the park commission to set trees, when they must do so; the cost being paid by the abuttor to the amount of $5 per tree, which is the maximum price the city can collect, and it is further provided that if the tree dies within three years the park commissioners must reset it without additional expense to the abuttor. In Essex county, New Jersey, and in several other cities, park commissioners may set and maintain trees along sidewalks near or leading to their different parks. In Hartford the official care of the street trees is with the board of street commissioners.

In Brooklyn and Manhattan and other cities, tree-planting associations have been organized and they have planted thousands of street trees in the last few years. All this shows that the value of trees on highways is fully recognized by all progressive people and communities, and that it is the prevailing sentiment of the present age that street trees should be owned, planted, controlled and maintained by the authorities having charge of the highways on which they stand, or by other commissions having special authority over the street trees other than the street department.

Existing conditions always will be a controlling factor in the proper layout and maintenance of street trees, and while certain general principles governing the proper care of trees are of importance in general, yet each city has to determine its own way and to overcome its own obstacles in order to arrive at the desired results.

The advantages of municipal ownership and control over individual ownership and management are very evident. Municipal ownership means systematical, uniform, practical and economical development and treatment, it means proper care at the proper time, which is of the utmost importance in regard to the devastating attacks of insects and fungus pests. It means improved appearance of our streets in all parts of the city. It means, last but not least, a better sanitary condition for the people as a whole, for medical authorities agree that the cultivation of trees in streets mitigates the intense heat of the summer and diminishes the death-rate of the children, for the trees give shade, and the foliage inhales the carbonic acid and exhales oxygen. There is no sound argument possible against the value of trees in our streets nor against the proposition to have them under the absolute control of the city government. And even the expense which a city will have to meet in the equipment and the maintenance of an official forestry department will be comparatively small considering the far-reaching benefits which all the inhabitants will derive from well planted, shady and attractive looking, tree-lined streets.

SECOND PART—THE STREETS AND TREES OF OUR CITY—WHAT THEY ARE AND WHAT THEY OUGHT TO BE.

A lack of good management in the general treatment of the street trees of Hartford is the most obvious feature. The causes for this are very evident to any one who thinks at all about the matter, and discussion of them may be dismissed in saying that it is the purpose of this report to try to point out the way to avoid such a state of affairs in the future, and to correct the existing conditions as far as possible.

The trees have been variously located along the traveled walk: in some cases between it and the abutting property; in most cases, between the traveled walk and the curb. Others, again, are in the adjoining land just inside the property line. The spacing is unsystematic and many stand too closely together, the necessary thinning having been neglected. Few trees, suitable for city streets, ought to be allowed to stand closer together than from forty to fifty feet. In almost every street there is a lack of uniformity in the selection of the kinds. In most of the streets which have been planted, there are long distances entirely without trees.

Nearly all have been badly neglected in the matter of pruning. Dead limbs are prevalent everywhere, and are not only unsightly, but are a menace to the health of the trees, and dangerous to passers-by underneath by their liability to break off and inflict injury. It may not be feasible to give every large tree that pruning which it seems to demand, but the larger dead limbs ought certainly to be removed. In the case of the younger trees it is to be hoped that all dead limbs may be removed, and that such treatment will be kept up in the future.

Only scattered attempts have been made to combat the various insect pests, of which there are a number. The worst of these, and the one most in evidence to the general public, is the elm leaf beetle. The most effective way to cope with it is by spraying. Last summer at Lafayette Square, the sprayed elms made a striking contrast to some of their unsprayed neighbors, which were badly defoliated. Besides the beetle there are the tussock, maple bark louse, the fall web worm, the oak pruners, and other insects.

In the writer's opinion the ideal location for [illegible] the street trees is between the property line and the traveled walk. When they are planted between the traveled walk and the curb they are nearer the dangers which menace them from the street. Placed thus, they are within the reach of horses, evidence of their destructive gnawing being altogether too common. The roots are nearer the influence of escaping gas from illuminating and sewer, and large vital ones which may have extended into the roadway are liable to be cut off whenever the streets are dug up. On the other hand, if placed between the traveled walk and the property line these dangers are pretty well eliminated, and there is the advantage that the roots can readily find their way into the adjoining land, and do not have to contend with the asphalt, macadam, or other unsuitable material which may be in the roadway. However, there are cases where, on account of the existing layout, it will be impossible to plant trees elsewhere than between the curb and the traveled walk, as for instance, where the inside grass strip is two feet wide and where the outside strip is nine feet wide; two feet not being wide enough. Five feet ought to be the minimum width. Trees placed in the middle of a nine-foot strip are removed from the immediate reach of horses, and if the soil is of good quality and sufficiently deep, say two feet, ought, unless untoward circumstances arise, to do fairly well.

Almost any street in the city with trees on it is an example of what the ideal street ought not to be in this regard. Farmington avenue being a well-known thoroughfare may serve as an illustration, combining many features which ought to be remedied if possible or avoided in future work. There is no uniformity in the selection of the kinds of trees, taking the avenue as a whole; rock, red and sycamore maples, elms, European and American lindens, horse chestnuts, and other kinds occur in a heterogeneous mixture, and are variously located inside and outside of the traveled walk. The ideal selection would have been one kind for the entire avenue, or several kinds, each kind planted by itself. The distance between two intersecting streets might, for instance, have been all elms, and between the next two streets European lindens. The pruning of the trees is like that of most of those elsewhere, that is, practically none has been done, and the trees contain a great deal of dead wood. Some of the rock maples have been severely butchered to let wires through their branches. Of late years the rock maples on the avenue and on some of the side streets have been dying. Just what the cause is, it is difficult to say. However, this fact is an argument in favor of the feeling now gaining ground among experts, that the rock maple is unsuited to city conditions. The spacing in some instances is too close and long stretches occur where there are no trees at all. A great many have been seriously injured on their trunks by the gnawing of horses.

No street in the city affords an example of the ideal. The nearest approach to this is, perhaps, Washington street. Standing at the northern end, and looking southwardly, the general effect is one of uniformity, the American elms predominating to such an extent that they seem on first inspection to be the only kind. A closer inspection reveals an admixture of other trees, irregular spacing and other defects.

The list of trees adapted to city conditions is a limited one. The ailanthus is preëminently the tree which stands more adverse city conditions than any other. Smoke and gas do not seem to affect it, apparently no insects attack it, and it will live and grow in a dry location amid asphalt and other pavements. Although for beauty it is not of the first order, it ought, for the foregoing reasons, to be quite extensively used. Others similarly constituted are the cottonwood, white poplar and some forms of willow. Next are the European linden and the English elm, both of which are tougher in this respect than the American species. All things considered, the best tree for the semi-urban and the suburban parts of a city, where it will have enough room, and where the soil is at least fairly good, is the American elm. Its advantages are a high but not too dense shade, the ease with which wires can be passed through its branches, its rapidity of growth, and the beautiful gothic way in which its limbs overarch a street. Its disadvantages are its lateness in putting out its leaves, its habit of shedding them continuously from about the middle of the summer onward, its earliness in losing them altogether, and its liability to attack by the elm leaf beetle. Although the habitat of the American elm is a moist locality, it does well even if planted where the ground is somewhat dry, seemingly having the power to send its roots a great distance in quest of water. The English elm, however, has proven in other cities to adapt itself much better to unfavorable city conditions, such as smoke and gas, and excessive drainage of the soil. It also holds its leaves during a longer period. Its worst fault is its greater attractiveness for the elm leaf beetle than even the American elm. Nevertheless it can be highly recommended as a street tree for the city of Hartford. Some other trees for the suburban portions of the city are red, scarlet, black, and pin oaks, horse chestnuts, hackberry, silver, and red maples and black walnut. Of all the trees frequently planted, the rock maple is probably the worst, although as a park tree it is one of the first merit. It is one of the first trees to succumb to urban conditions as the city reaches out into the country. If it is planted thickly along a street, and thrives, its shade is too dense. The smallness and multitude of its branches make it difficult to treat it to allow telephone wires to pass through. Linemen say that it is absolutely essential that not the least twig be allowed to touch such wires. In order to prevent this in the case of the rock maple, there is no other way than to cut a great hole in the heart of the mass of branches, and this, if left to the average lineman, usually results in ugly and injurious mutilation. If used at all as a street tree, it ought to be planted only sparingly on the side streets of the more rural portions of the city. The Norway maple is often planted, and stands city conditions quite well, but it has some of the objectionable features of the rock maple, namely, the denseness of its shade, and its branchiness, and consequent unsuitableness for electric wires. Judging from the somewhat limited data furnished by experience in other cities, the gingko promises well as a street tree. It is to be hoped that a trial will be made of it in Hartford.

Without making recommendations in detail for the future treatment of the streets of Hartford as regards trees, it may be well to draw attention to a few thoughts on the subject in order to give an idea as to what might be accomplished if this whole matter were systematically managed under one head. Let Franklin avenue serve as an example. Its length combined with its straightness makes it adapted to form a fine avenue of trees. It would be well if the comparatively few existing trees, which might interfere with the design of planting, were removed in order to secure that uniformity which is so desirable in city streets. The avenue might be planted in sections with the different kinds. A tentative list might be, beginning at its northern end, and going southwardly,—ailanthus, cottonwood, English elm, American elm, pin oak and red oak. On some of the narrower streets and on those streets on which the building line is near to or on the inside line of the sidewalk strip, large trees are not feasible. In cases like this, the practice followed in some European cities is suggested, namely, that of planting trees which would attain a large size if left to grow naturally, but which in this case are allowed to attain only a certain size and then are practically kept there by severe pruning. Trees so treated have a somewhat unnatural appearance, yet they are better than none at all, and their foliage affords a grateful shade and a pleasant rest for the eye. The experiment might also be tried in similar cases of using the Lombardy poplar, not for its shade, which is not wide enough, but because of its columnar form of growth, which requires but little space. It seems that it ought to be effective in an architectural way, and that it would relieve some streets of their monotony. In regard to other streets, it is only necessary to say that there are a great many where planting can be done, but has not been, which will some day need the attention of the tree planter.

THIRD—CONCLUSIONS AND RECOMMENDATIONS.

Whereas, A thorough and practical investigation has been made by this committee regarding the present system and condition of the trees within the streets of our city; and

Whereas, Said investigation has resulted in the gathering of a number of salient facts showing the existence of undesirable conditions and the pressing need of a more systematic and uniform management, and the need of better care and maintenance of the trees at present existing; therefore, be it, and it is hereby

Resolved, That in the opinion of the members of the Hartford Florist Club, the system of planting and caring for the street trees of the city of Hartford is not properly developed, and that generally the trees are not well cared for; and it is further

Resolved, That it is the judgment of this meeting that all trees standing within the limit of all highways of the city of Hartford, should be planted, maintained, and controlled by the city government; and it is further

Resolved, That it is the opinion of this meeting that a forestry department should be created with a sufficiently yearly appropriation to develop and maintain the tree planting along all highways in an efficient and practical manner, that said department should be under the jurisdiction of proper authorities, and should be clothed with sufficient power to carry on its work after a uniform and systematic plan; and it is further

Resolved, That this report be transmitted to his honor, the mayor, the honorable court of common council, the board of street commissioners, the board of park commissioners, the board of trade, the Civic club, and the Landlords' Association, with the respectful request that they give the subject their careful consideration, with the object in view to devise such plans and take such action as may lead toward the desired results.

All of which is respectfully submitted.

THEODORE WIRTH, *Chairman,*
G. A. PARKER,
ROBERT KARLSTROM,
HANS J. KOEHLER,
J. WESSON PHELPS,
Committee.

SALTONSTALL TUNNEL

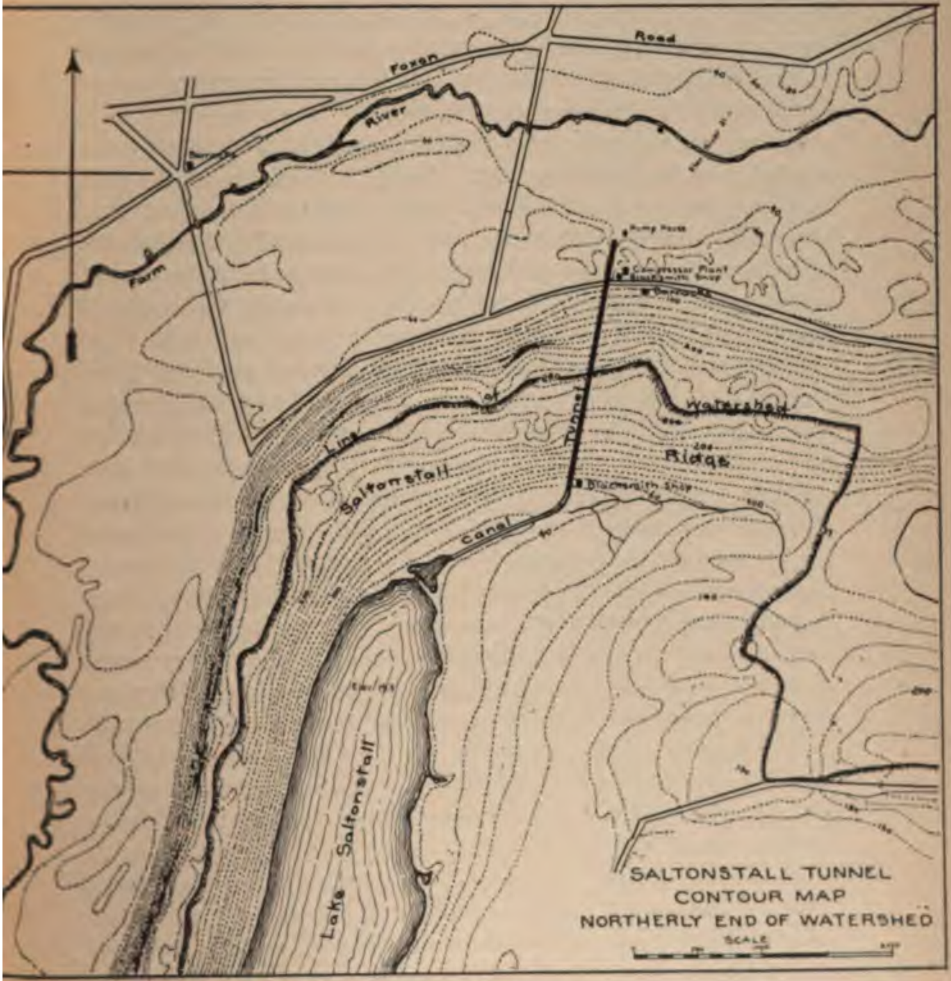
CONNECTING THE FARM RIVER DRAINAGE AREA WITH LAKE SALTONSTALL.

Built by the New Haven Water Co. in 1901.

By Edward E. Minor, New Haven, Conn.

Lake Saltonstall lies four miles southeast of New Haven. It forms one of the low level supplies for city water. The watershed consists of four square miles of rocky, woody country, with but few houses on it, and draining into an ideal reservoir at an elevation of twenty feet above mean high water. The lake extends three and one-half miles along the easterly foot of Saltonstall Ridge, averaging a quarter of a mile wide and with a depth of over 100 feet. The sides are steep and rocky. It has a storage capacity of 135 million gallons for one foot in depth. The development of this supply was designed by Phineas Ball in 1882. A pump house containing a Worthington compound pumping engine with a capacity of 7 million gallons a day is located at the southerly end of the lake. Water is pumped from the lake to a standpipe on the ridge directly back of the pump house. It then flows two miles through East Haven to the distributing reservoir in Fair Haven. This has a capacity of 6 million gallons. Future development was contemplated in a connection with Farm River, either by tunnel or pumping station. Farm River flows in the valley west of Saltonstall Ridge and drains an area of fifteen square miles.

In 1900, a year of exceptional drought, it was seen that in such an emergency further provision was needed for water supply. The development of Saltonstall commended itself for several reasons. It gave an additional water supply from fifteen square miles, which in dry seasons would be of much value. It utilized the exceptional qualities of Lake Saltonstall as a storage reservoir, with its attendant improvement of the water. The Fair Haven reservoir was of value, too, because of its location, which enabled it to supply a part of the city remote from the other reservoirs. There was also given, in case of drought the succeeding year, an opportunity of so pushing the work as to use the Farm River water.

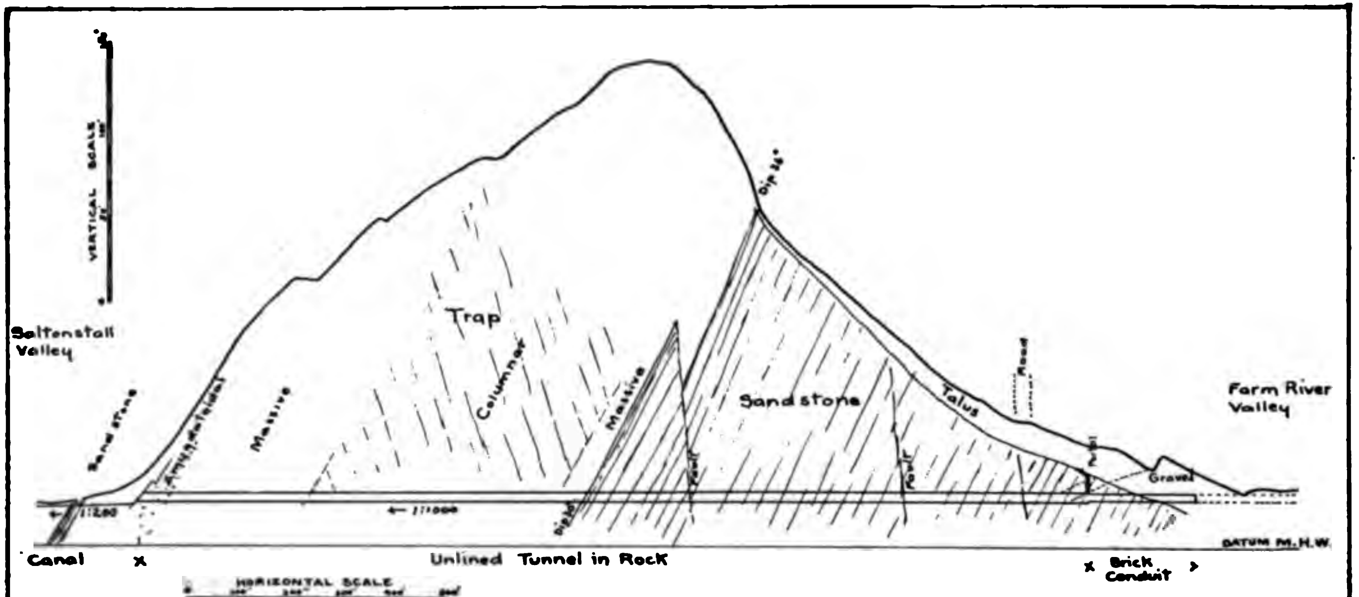


As a preliminary step in the consideration of this development, a series of benches had been run some years before in each valley. From these, details of the topography were worked up, in connection with a general map of the whole region. From this the position of the tunnel was located a short distance above the head of the lake. The line was cleared of trees and test pits dug to determine the position of the rock at the foot of the Ridge. The surface contact between the sandstone and the trap on the northerly face of the ridge was uncovered and from its dip an idea was given of the probable length of tunnel in each. A canal was dug from the lake up to the south end of the tunnel. This gave the contractor an opportunity for drainage at that end.

In locating the axis of the tunnel in the field, two points were needed in seeing over the ridge. Each of these was constructed so as to form a signal, toward which work at the portals was directed. Grade and distance were determined from three sets of measurements over the ridge. At each end of the tunnel points were established for adjusting the transit for line and grade, and these were always tried before doing any work.

Saltonstall Ridge consists of a thick sheet of trap rock dipping at this point about 35° S. and underlaid by strata of shales and sandstone. The three extrusive flows of lava, which visited the Connecticut valley in times past, are here found close together. On the northerly side of the Farm River valley are the trap rock hills of the first flow. This averaged from one to two hundred feet in depth. On it were laid the sandstones and shales, which extend up under Saltonstall Ridge. Here the lava came as a part of a main flow from four to five hundred feet in depth. Its protecting influence can be seen in the range of hills extending up through Totoket Mountain to the Hanging Hills of Meriden. On the southerly side of the Saltonstall valley, we find a ridge formed by the third flow, which was only about 100 feet in depth. The upper surface of these trap ridges show a rock of a brown, earthly color, full of small holes, easily drilled and broken.

Bids were received from eight contractors in December, 1900. The work specified was the construction of a tunnel 2,000 feet in length, through trap, sandstone and earth, and the lining of this with brickwork and concrete, if desired by the Company. The average price bid per lineal foot of tunnel in trap was $19, in sandstone $17, and in earth $14, and for lining $13. These prices included necessary timbering, suitable centers and forms. Work was to be carried on continuously with compressed air



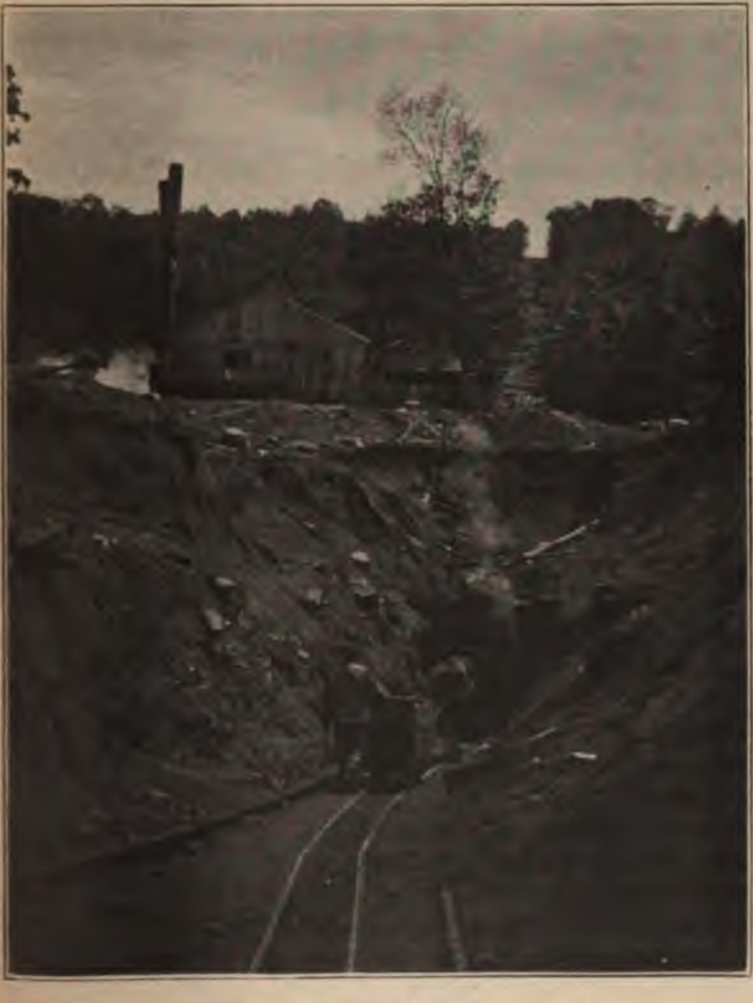
SALTONSTALL TUNNEL
PROFILE

for power and electricity for light. This latter was not used, however. No camp was allowed within 500 feet of the lake, nor within 200 feet of any watercourse. Strict regard as to its sanitary condition was also specified.

The lowest bid for the work was given by Dravo & Co. of Pittsburg. They were awarded the contract and began work early in January, 1901. A pump house was established in the Farm River meadows, a compressor plant and blacksmith shop near the north portal, and a blacksmith shop also near the south portal. Steam was furnished by two horizontal boilers to a compound engine driving a two stage Ingersoll-Sargeant compressor. A three-inch pipe line was laid across the ridge ending on each side in a section of eight-inch pipe, which was intended to serve as a compressed air reservoir. This was supplemented later by a large compressed air tank set up in the compressor house. By a combination of ¼ bends a flexible joint was made in the pipe line on top of the ridge. This tended to relieve strains on the pipe joints due to a gradual working of the pipe down the ridge.

Work on the south side started in the trap directly on the grade of the tunnel. On the north side this was not possible. As the grade of the tunnel came below the level of the river, to avoid floods an open cut was started part way up the slope. This was carried down on a 10 per cent. grade, shown by dotted lines on the profile, until the grade of the tunnel was reached. From here the work was carried forward on the lines of the tunnel. Points were put in about fifty feet apart and consisted of a heavy eye screwed into a plug set in the roof. These were over the axis and their plus and distance above it given the foreman. Line and grade were given with a Stackpole transit, centered on top and sighting at an acetyline light placed in back of a plumb bob for line and in front of an ordinary level rod for grade, with the light thrown on the target. No appreciable effect on the instrument from moisture or change of temperature was noticed.

No material was dumped out on the Farm River meadows, all being placed within the gully indicated by the contours on the general map. As work progressed through the sandstone much water was encountered in the looser strata and though the shales were often decomposed and loose, none of the seams were large enough to need timbering. One exception, which occurred at a place where there had been some local movement, was timbered. These were afterwards blown out by an irresponsible workman, so that even they were proved unnecessary. Much of the sandstone was of a grayish color and quite hard. The débris from the blast would set together, so as to make it



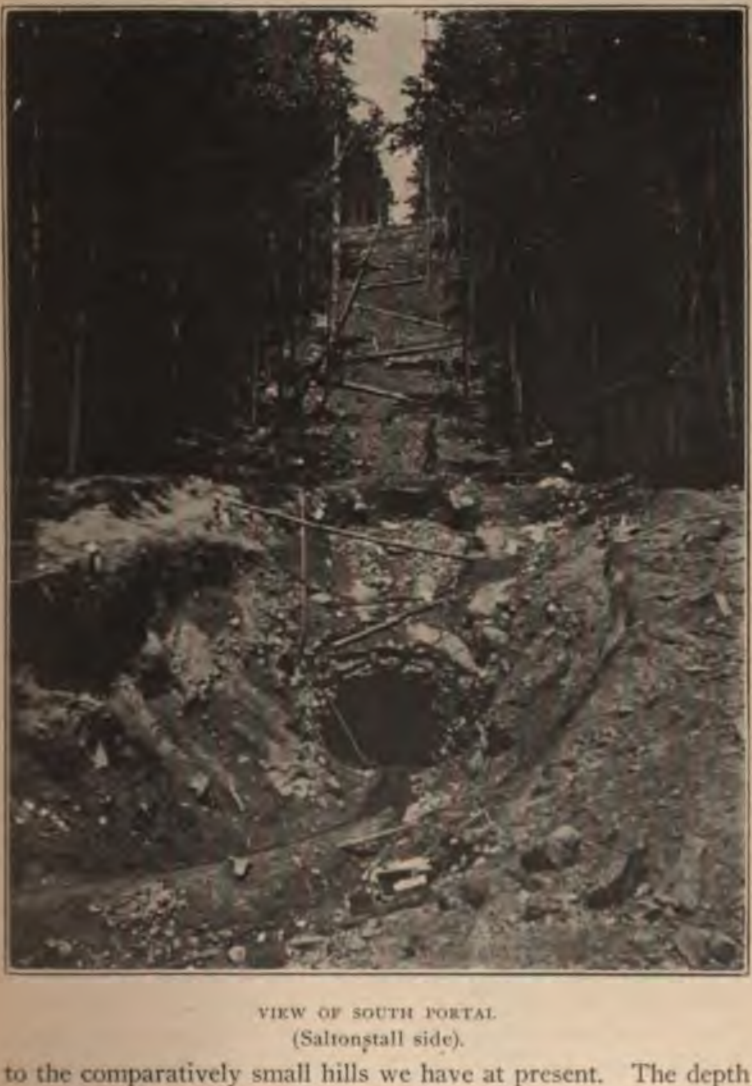
VIEW OF NORTH PORTAL (FARM RIVER SIDE)
showing Compressor House.

impossible to shovel without picking. A steam siphon was first used to keep the water out of the heading. This was later supplemented by a compressed air pump. After driving the tunnel in about 400 feet these proved insufficient and a sump was made on one side of the tunnel and a steam pump installed. The exhaust from this was carried to the portal in a wooden box.

Two drills were worked in each heading and the work carried on night and day. It was found that a six and one-half foot circle was about as small a heading as could be occupied by four men and two drills. The average rate per day in sandstone was ten feet and in trap five. The contractors, when the work was about half finished, gave each man a small bonus for each foot over ninety driven per week.

Thirteen holes were driven to a heading. There were a set of center holes converging toward a point just beyond the position of the next heading, a set of side holes and two on top and on the bottom. The center holes were blown first, taking out a core in the center which practically fixed the position of the next heading. The sides were then charged and blown, and then the top and bottom holes. There was considerable difficulty in entering the tunnel and doing this work after the first blast, as the gases were often strong enough to lay a man out temporarily. The progress of the work depended in great measure on the care with which these headings were drilled and blown. At first, holes from ten to twelve feet deep were drilled in the sandstone. It was found impossible for one shift of men to finish drilling and cleaning up a heading, and it was very hard to get a fresh set of men to go on with the work planned and started by the others. Accordingly holes were driven only about six feet, and each heading cleaned, drilled and blown by the same men. This proved not only more satisfactory but fully as expeditious. All rock was taken out of the tunnel in small cars run on a narrow gauge track and drawn by horses.

In the trap rock, reverse conditions from the other side were met. Everything was dry and exceedingly hard. The structure of this lava flow was very clearly and interestingly shown as the tunnel passed through it. The main features are shown in the accompanying profile of the ridge. Where the tunnel entered, the trap was about fifty feet from the original surface. This is shown in the bed of the brook opposite the southerly end of the tunnel, where sandstone lies in place and above the trap. This missing strip, which evidently is much thicker higher up the ridge, was eroded off by the immense field of ice, which once covered these regions, planing mountains down to the comparatively small hills we have at present. The depth of Lake Saltonstall undoubtedly comes from this same cause. For fifty feet the trap was filled with small nodules of calcite, which had been deposited in the blowholes formed by the escap-

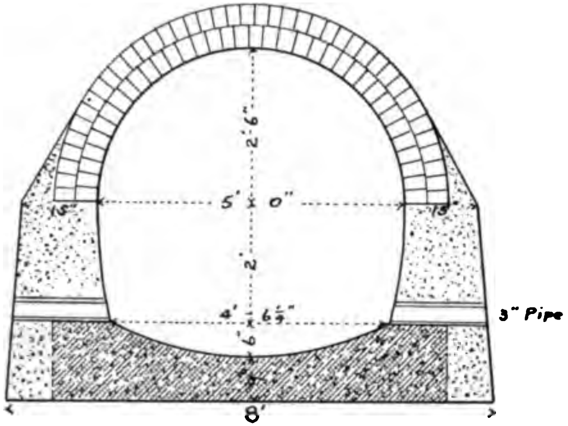


VIEW OF SOUTH PORTAL
(Saltonstall side).

ing gases of the lava flow. The trap was not noticeably hard, it being possible to drill and blow a set of five-foot holes in ten hours. This gradually changed to a much harder rock, massive in structure and comparatively free from the calcite nodules. From here on it was just possible to get in a set of five-foot holes in twenty-four hours. It became very hard to get steel that would stand against it. Three hundred feet from the portal the trap began to show a marked columnar structure at right angles to the flow. Here, owing to the heat in the center of this lava flow, conditions were formed more like those of the intrusive dikes, East and West Rock, and the trap was similar in structure and appearance. The trap kept at a uniform hardness, allowing a daily progress of about five feet. The columnar structure continued to within about forty feet of the contact, where it again became massive and where small, spreading veins of calcite appeared. Directly at the contact the appearance of the trap changed in places to a grayish color, fading out imperceptibly into the darker color of the adjacent rock. The two headings came together within half an inch for line and grade.

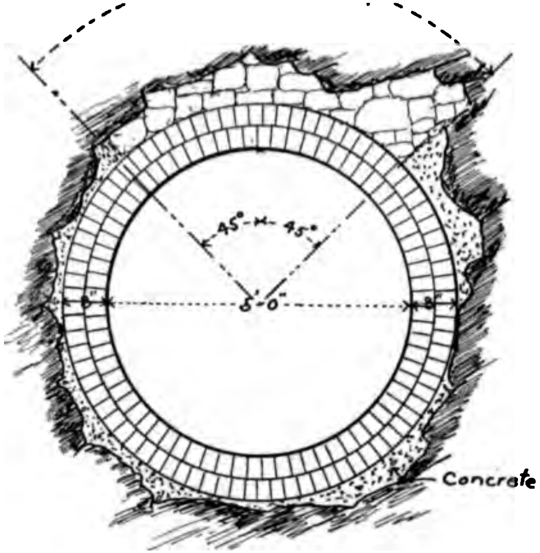
No lining was put in the rock. At the north end the steep incline was taken [illegible] and the excavation carried down in a trench to the tunnel level. This trench was excavated in a fine gravel carrying much water. A section of conduit about 200 feet in length was built through this of a cross section differing somewhat from that planned for the tunnel but which could be carried through the rock later if desired. The part of the cross section containing the invert and a shoulder under each side wall, shown by the shaded portion on the accompanying plan, was put in first in alternate blocks ten feet in length. This gave the water a runway on each side. When these had set, the sides were dammed up, the flow diverted to the invert and the side walls put in up to the springing of the brickwork. This conduit was carried through about to the Farm River meadows, where work was stopped. The completion of the work consists of an extension of this conduit out to Farm River and the construction there of a forebay, and weir providing a certain minimum flow down the river. The tunnel stands at present not so much a source of water supply as a means whereby in an emergency an additional water supply could be obtained.

EDWARD E. MINOR.



SECTION OF CONDUIT
FARM RIVER VALLEY

Note Concrete 1 cement, 2½ sand, 5 cleaned gravel.
Mortar 1 " 2½ "



PROPOSED LINING
(NOT USED.)

SALTONSTALL TUNNEL
SECTIONS

CLEANING A LARGE BRICK SEWER IN HARTFORD, CONNECTICUT.

By Frederick L. Ford, City Engineer.

During the past season considerable work has been done in cleaning the Franklin avenue sewer, one of the largest in the Hartford sewerage system, the results of which may interest engineers called upon to estimate on or have charge of similar work. While we do not claim any novelties in the system used for cleaning, we believe we have obtained very satisfactory results.

The sewerage system of Hartford is wholly built on the combined plan, providing for sewage and surface water, and consists at the present time of about 87 miles of main tile and brick sewers, all built since 1844, the date of the first sewer in Hartford. Most of the sewers have sufficient grade to produce self-cleaning velocities, so that the maintenance account of our sewer system is reduced to a minimum.

The Franklin avenue sewer cleaned consists of 9,269 lineal feet of circular brick sewer, 5,128 feet of which is 6 feet inside diameter; 2,225 feet, 4 feet, and 1,916 feet, 3 feet inside diameter. This sewer was built in 1872-73, at a cost of about $150,000, and drains a district containing about 1,167 acres. It has never been thoroughly cleaned since it was built. The sewers which discharge into this trunk sewer vary from 8 inches to 3 feet in diameter, and have grades ranging from 0.5 to 6.0 feet per hundred. The 6-foot Franklin avenue sewer has a grade of 2 feet per 1,000, and the 4 and 3-foot sections a grade of 3 feet per 1,000.

This trunk sewer, although considered entirely too large at the time it was built, is now hardly sufficient to provide for all the water collected during severe storms, and considerable difficulty is experienced by the flooding of cellars and basements adjacent to this large sewer. This condition has come from the rapid growth of the district and the gradual change of a large part of the district from an absorptive to an impervious surface.

On account of the congested condition of this sewer, we started some experiments the past season to determine the location and extent of the nuisance, and also to measure the amount of water passing off from this district during severe rain storms. It was during the organization of this work we discovered the serious condition of this sewer. The first work done was a thorough inspection of the sewer to determine the location and amount of the deposits. In the 6-foot sewer this was an easy task with lanterns, and the material was found only in patches on the bottom, averaging from 6 inches to a foot deep and from 50 to 150 feet in length, located usually just below where some large tributary sewer entered the Franklin avenue sewer.

It was impossible to make a thorough advance inspection of either the 4 or 3-foot sections of the sewer, as the manholes were, as originally built, sometimes 1,000 feet apart, and the ventilation so bad that we found it suffocating and too dangerous to enter either for any great distance from any manhole.

The deposits in the 3-foot sewer were found, upon opening the sewer, to average about 1 foot in depth and the ordinary sewage, about 6 to 8 inches, was running on top of it, so there was little available working space left.

As the magnitude of this work was a very indeterminate quantity, it was decided best to engage a competent sewer contractor to furnish all materials and labor and superintend the cleaning on a 15 per cent. basis. He selected a foreman at $15 per week, and for laborers some trustworthy Italians, who, from their small size and rugged constitution, were best adapted for this work, and paid them $2 per day, 50 cents more than they ordinarily received on sewer work.

Before commencing the cleaning, manholes were built where necessary, so that they are now not more than 300 feet apart, and often less on the smaller sizes.

In cleaning, the force was organized in small gangs, which could work to advantage; two starting in at a manhole and working in opposite directions until they met the men coming in the opposite direction.

In the 6 and 4-foot sections, wheelbarrows were used to convey the material removed to the nearest manhole, where it was hauled up and removed in carts, each holding 1 cubic yard. In the 3-foot sewer the men used pails to remove the deposit.

The result of the work is as follows:

Diam. Sew.	Length.	Loads.	Cost.
6 Feet.	5,128 ft.	107	$387.55
4 Feet.	2,225 ft.	61	243.80
3 Feet.	1,916 ft.	107	466.38
Total,	9,269 ft.	275	$1,097.73

The average cost per load (cubic yard) on 9,269 feet of sewer was $3.99, and the average cost per lineal foot was $0.118.

Size of Sewer, ft.	6	4	3
Cost per load	$3.62	$3.99	$4.36
Cost per foot	0.075	0.109	0.243

The 6-foot sewer was cleaned in 7 days. The total time on this work, including foreman and team, was 1,592 hours. This is equivalent to 22.7 men working 10 hours a day for 7 days.

The 4-foot sewer was cleaned in 4 days. The total time was 1,000 hours, equal to 25 men employed 10 hours a day for 4 days.

The 3-foot sewer was cleaned in 13 days. The time occupied was 2,019 hours, or an average of 15.3 men, working 10 hours a day for 13 days.

The average distance cleaned by each man per day on the 6-foot sewer was 32 feet, on the 4-foot sewer 22 feet, and on the 3-foot sewer 9 feet.

The total cost of the work, including manholes built, was $1,395.47, of which 15 per cent. was paid to Mr. Charles H. Slocomb, who furnished the labor and materials and superintended the work.

IMPROVEMENT OF A WEB PLATE GIRDER BRIDGE

AT HARTFORD, CONNECTICUT.

By Henry Robinson Buck, Assistant City Engineer.

The New York, New Haven & Hartford Railroad some time ago completed alterations to a bridge in Hartford which are of a rather unusual nature. Since the changes are such as might be made in any bridge similarly located, and as the results have amply justified the outlay, the matter may be of interest to others.

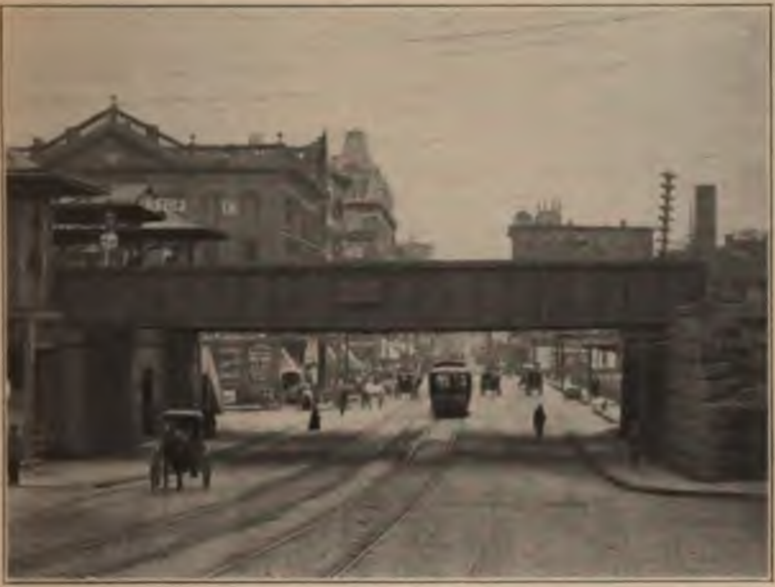
The bridge carries the four main tracks of the Hartford and Highland divisions over Asylum Street, just south of the Union Station. It consists of four plate girders 7 feet 9 inches deep and 77½ feet extreme length, forming two through bridges with a clear span of 70 feet. The crossing is skewed, with the tracks on a curve, so that the bridges are not parallel, and there is an open space of from 12 to 15 feet between them. The floor system in each consists of beams about 2 feet deep spaced 7 feet apart, carrying stringers 14 inches deep on which rest the ties. To prevent dripping onto the street, corrugated iron arches were sprung between the lower flanges of the stringers, and tar concrete deposited over them to a depth of some 5 inches above the center of each arch. A gutter was formed at one side of the arch next to each stringer, with holes cut through the webs of the transverse floor beams to allow the water to flow through from the center to each end of the bridge. The gutters had a fall of a quarter of an inch to each floor beam, amounting to a grade of about three-tenths of one per cent. The whole system was given a thick coat of asphalt, and for a time it made a water-tight and satisfactory floor.

The bridge is now, however, over thirteen years old, and for a long time past there have been abundant signs that the waterproofing was going to pieces. Greasy water dripped on the sidewalks below for a long time after every storm, showing that the water was being ponded by the floor beams, and instead of running rapidly to the scuppers at the ends of the bridge, was slowly filtering through the now defective asphalt. The bridge was boarded over just below the rail heads with matched pine boards, but there was no grade to this flooring, and from the nature of the case it could never be tight.

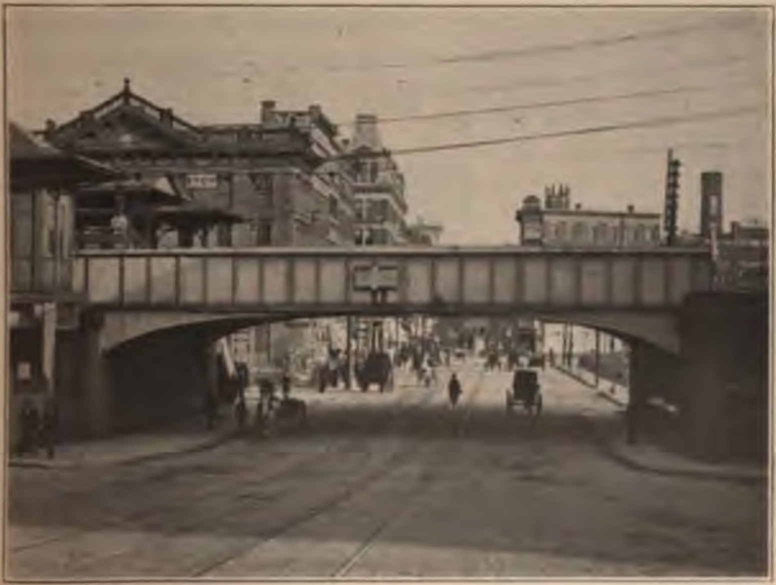
Several plans were recommended for remedying the nuisance, and early in 1902 the railroad company put up one of the usual wooden fans over one sidewalk, the slope being away from the abutment so that the water would drip into the street beyond the curb line. This would have cured the difficulty, but the roof was so extremely unsightly that great objection was made to it, and it was at once taken down. Plans were then drawn for a corrugated iron arch to span the whole street. It was to be hung from the floor beams and covered with asphalt, in order to shed the water into troughs next to the abutments. This was not built, however, as the record of the waterproofing in the original bridge seemed to show that its life would have been short. It would also have been quite expensive.

The method finally adopted was originated and designed by Mr. Frederick L. Ford, City Engineer. He proposed wooden fans, similar to the usual type, but sloping toward the abutments, and masked by galvanized iron brackets at each end. These brackets, the use of which are possible only when the fans are sloped opposite to the usual way, give this improvement its distinguishing character. Far from disfiguring the original structure, their curved lines add a touch of grace seldom seen in a plate girder.

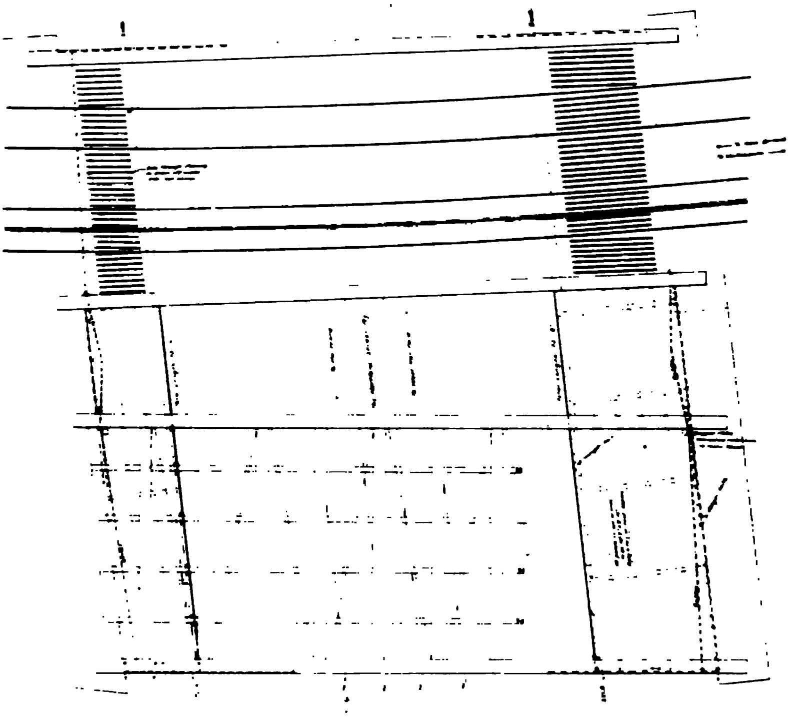
The fans are suspended by wrought iron clips from the bottom flanges of the floor beams. They are framed of 3 inch by 6 inch southern pine joists which form panels 10 feet 7 inches by 2 feet 10 inches center to center, with ⅞ inch sprung moulding around the sides of each panel. The sheathing is of first quality southern pine ceiling boards, matched and beaded, and along the outer edge of the roof (that is, over and parallel to the street curb) is a panelled edging 6 inches high. All exposed surfaces are heavily varnished, and the general appearance of the whole is quite handsome. In the center of each middle panel, forming a row over each sidewalk, is an incandescent light with porcelain reflector, which will effectually light up a now dark place under the bridges.

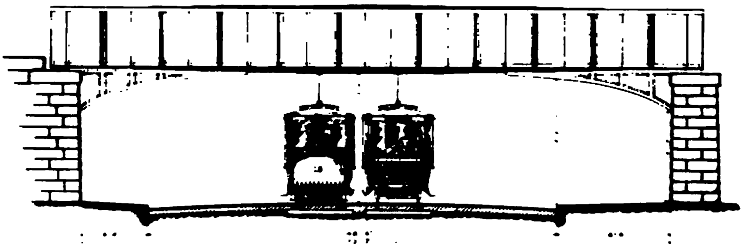


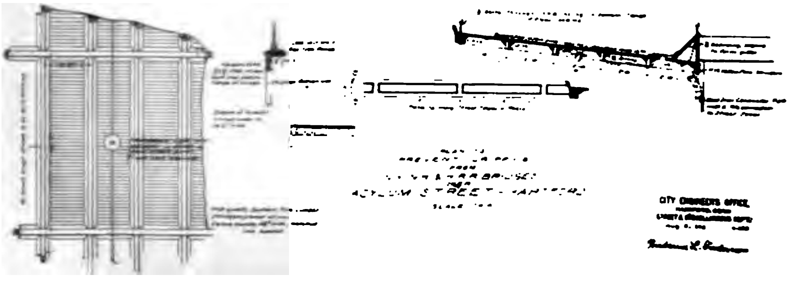
BRIDGE BEFORE CHANGES.



BRIDGE AFTER CHANGES.






CITY ENGINEER'S OFFICE

To insure the permanent tightness of the roofs their upper surfaces are sheathed with 16 oz. sheet copper. Gutters are formed on each by inclined boards which fit against the top of the abutments, over which the copper is laid, conducting the water through two scuppers in each roof to drains laid to the street sewer. Both fans are continuous from side to side of the bridges, thus forming a roof over the space between them.

Directly under this formerly open space is an exit from the depot, and the new construction thus makes the bridge practically a sheltered extension of the train platforms, so that passengers can now take the trolley cars without having to go out from under cover.

After the fans were up the old concrete was completely removed, thus taking off about forty tons of dead load from the bridges and affording a much needed opportunity for inspecting and painting the iron work of the floor system.

Excessive drip over the roadway is prevented by ⅞ inch pine sheathing, laid close up under the rail heads at the center of the bridge and sloping down to the base of the rail over each fan, upon which the water is drained through slots. No special precautions were taken to make this part of the work water-tight, beyond a thorough painting, as it was not thought essential to entirely prevent drip over the roadway.

The four brackets which mask the ends of the roofs were designed to look like sections of arches supporting the main girders. They seem to the eye to strengthen the whole bridge, and are extremely pleasing, by reason perhaps of their apparent usefulness. The fan on the north side of the street is 14 feet 6 inches wide while that on the south side is only 9 feet, but this inequality is not noticed, as the brackets were of course made symmetrical, running out in each case 19 feet 6 inches. They are built of 22 gauge galvanized iron soldered up into panels, the ribs of which correspond with the stiffeners of the girder above. They are hung by inconspicuous clips from the bottom flange of the main girders.

The total cost of the improvements was about $3,000, which is much less than any efficient asphalt waterproofing would have cost.

The suggestion is offered that new highway bridges might well be fitted with drip fans arranged like the ones described, and masked by similar brackets.

Web girders never look beautiful, but these brackets make them decidedly less ugly at little or no additional cost.

DOUBLE SEWERS.

In most city streets of moderate width the prevailing practice of locating a single sewer in or near the center of the street is probably the best plan. Where there are alleys in the center of all blocks, the alley seems to be the right place for the sewer. On broad streets having a grass plat on each side of the driveway two sewers, one in each grass plat, make a convenient arrangement. When the streets and houses are all owned by one corporation, as they are in many of our large manufacturing villages, a separate sewer for the houses on each side of the street is often best.

The houses in the village owned by Ponemah Mills are generally 46 feet long and spaced 36 feet apart and the distances from the house front on one side of the street to the house front on the other side is 70 feet. As the houses were double and the fixtures were at the ends a house drain was required at each front corner. Circumstances made it better in this case to have the sewers in front of the houses, and they were put within five feet of the front of each row of houses.

This plan was found especially satisfactory for two reasons: First, it made the house drains very short. In fact each house drain consisted of one length of soil pipe and one Akron eighth bend. Leaded to the soil pipe inside the cellar was a 4 inch by 4 inch Y branch with a cleanout plug in the straight run, which enables the whole soil pipe to be cleaned from the cellar with an 8 foot rod, a very desirable thing in tenement house drainage.

Second, there was no disturbance of the street surface except where the sewers crossed lateral streets. The one sewer plan with house connections averaging 41 feet apart on each side would have done the streets injury from which they would not have recovered for a considerable length of time. The soil in front of the houses was so well replaced that a week after the completion of the sewers in a street little evidence of disturbance remained.

In a system buillt for the Wauregan Co. the present season the same plan was adopted, except that the rear of the houses furnished the best position and the sewers were placed five feet therefrom. With the same advantages of short house drains and undisturbed streets mentioned heretofore, there was the additional advantage that on account of the location of the houses there was a saving in length of sewers and drains.

In both villages sewers were for sewage only. In each case all the house drains and water service pipes were laid at the same time and in same contract with the sewers. Sewer and water pipes were laid in same trenches.

The sewer systems of each village were designed by C. E. Chandler and S. B. Palmer of Norwich, Conn., and constructed by the Hartford Paving and Construction Co. of Hartford, Conn.

GATE-VALVE AND STORM OVERFLOW CHAMBER

FOR GOODWIN PARK, HARTFORD.

By Roscoe H. Clark.

The accompanying illustration shows a combined valve or gatechamber and storm water overflow which was designed to meet peculiar conditions confronting us; first, in taking care of the surplus water from our proposed pond in Goodwin Park; second, in providing the means for draining the pond when necessary; and third, for maintaining at different seasons of the year different elevations of the water surface.

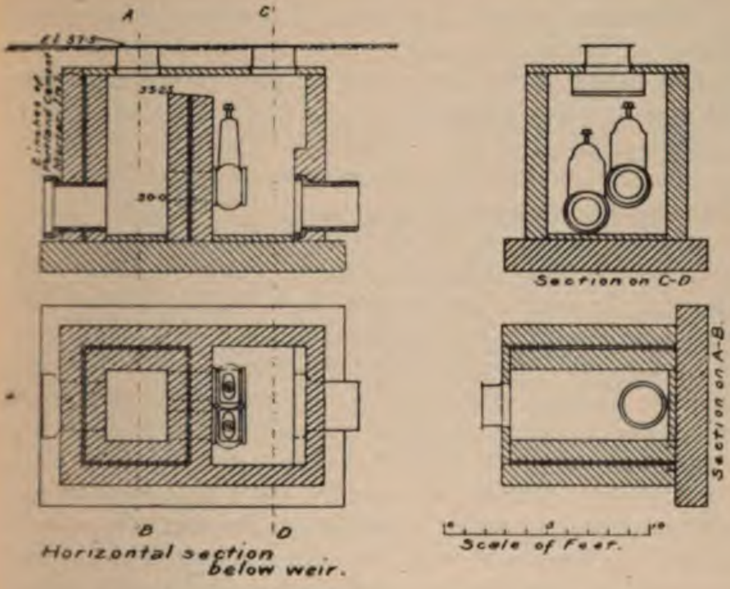
The structure itself consists of a brick vault, or chamber, divided into two equal parts by a weir. One of these chambers (the one on the left of the illustration) is the receiving well, and in it the water stands on a level with that in the pond. This part has double brick walls of 12 inch thickness separated by a 2 inch layer of Portland cement mortar composed of one part by measure of American Portland cement to one part of clean sharp sand.

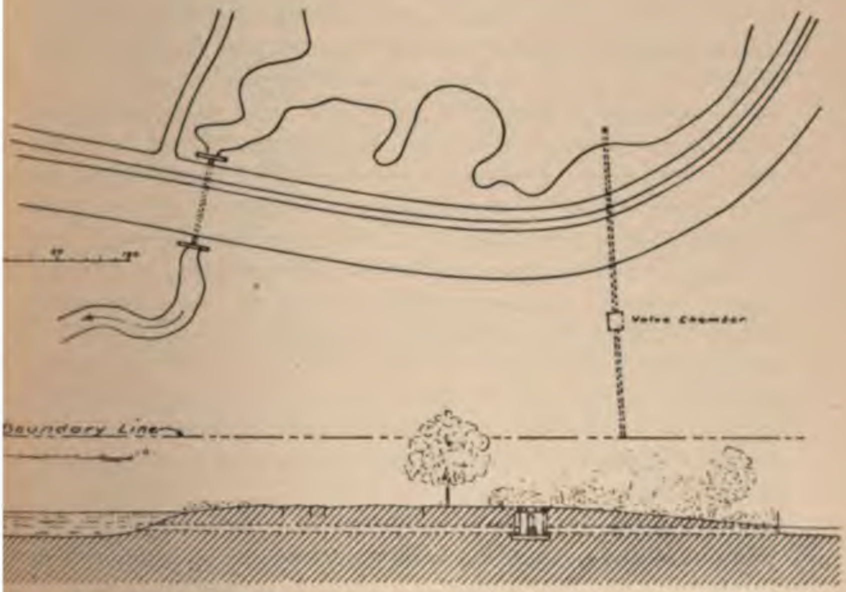
The other part is the gate chamber proper, and contains the two 16 inch valves, the use of which is described further on. This chamber has 12 inch walls on two sides, while the end is an 18 inch wall for about one-half the height, with a 12 inch wall the remainder.

Each chamber has for a floor a blue-stone flag 4 inches thick in order to prevent wash of the concrete foundation, and digging into the same when cleaning out sediment. The structure was covered with two similar pieces of flagging, in which were cut holes for entrance, and smaller ones for the insertion of keys for opening and closing the valves.

The walls were plastered on the inside with a layer of Portland cement mortar one-quarter inch in thickness.

The entire structure rests on a foundation of Portland cement concrete 18 inches thick, consisting of one part cement, three parts sand, and five parts broken stone, extending 12 inches beyond the brick walls on every side.


A
C
El 37.5
2 inches of Portland Cement Mortar 1:3
35.25
30.0
Section on C-D
Section on A-B
B
D
Horizontal section below weir.
0 5 10
Scale of Feet.



VALVE-CHAMBER
GOODWIN PARK.

In the summer season it is intended to maintain the surface elevation of the pond as near 55.0 as possible; hence the skim overflow, which is through a 24 inch pipe culvert under the walk and drive (as will be seen on the left of the sketch plan), is placed at 54.5. This is accomplished by means of another weir placed a short distance above the entrance to the culvert, which latter is so placed that in time of freshet the 24 inch culvert pipe will be running full before the water in the chamber rises to the bottom of the cover stones, which is about 56.5. Whenever the water rises to 55.25, however, it begins to flow over the weir between the chambers, in which the area of opening is considerably larger than that of the 24 inch pipe which forms the entrance to the chamber. From here it runs away through the 24 inch waste pipe, and spills out in the bed of a small water-course, which was the original outlet of the vicinity.

In winter it is intended to lower the water in the pond 5 feet to elevation 50.0, in order to provide safe skating. In order to maintain this level, a 16 inch iron pipe was built into the wall below the weir and provided with a valve. In the fall, before very cold weather, this valve is to be opened and the water in the lake will then drop to the required level, the valve of course being left open till spring. In order to drain the pond when necessary for the removal of undesirable growth, or for other purposes, a second 16 inch pipe with valve was built into the wall, but at a level with the bottom of the 24 inch inlet pipe. The mode of operation is obvious. Unfortunately the very slight grade of the bed of the brook beyond the park boundary made the placing of the entire arrangement low enough to drain the lake to the bottom impracticable; and as it is desired to have a maximum depth of 8 feet, there will always be 2 feet of water at the bottom which will not drain away. It is improbable, however, that it will ever be necessary to completely empty the lake.

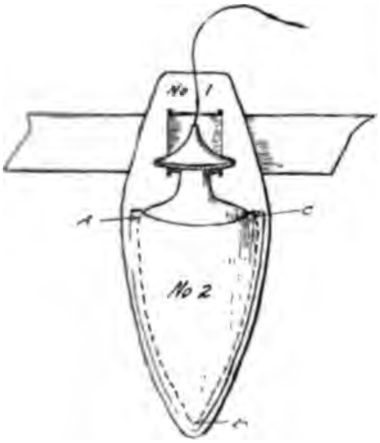
Not the least of the advantages of this arrangement over the ordinary one of bulk-head and flash-boards is the entire absence of any unsightly features, the whole being below the ground, nearly 200 feet from the shore of the lake, and on the opposite side of the drive, where even the covers of the manholes can be planted out and thus screened from view if desired.

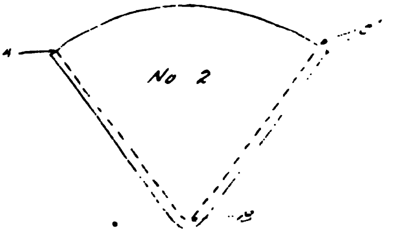
The pipe used was 24 inch Akron tile, 3 foot lengths. The manhole frames are cast iron, of the ordinary type.

A PLUMB-BOB POCKET.

By Elijah H. Owen, Hartford.

The accompanying sketch shows a pocket for plumb-bob, to be worn on a belt. I first saw one of these devices in Mr. Minor's office at Greenwich. He got the idea from Mr. Kirby of Portchester, N. Y., who conceived it. As it is inexpensive and decidedly useful, I herewith, with consent of the "inventor," bring it to the attention of the members of this association. As seen in the sketch, it is simple of construction. Any harness-maker can make one from two pieces of scrap leather.





No. 1, the back, should be fairly stiff, and is provided with two slits near the top, through which the belt passes. No. 2 should be cut so as to make a close fit for the bob, its entire length. Under the point enough room should be left to prevent the bob from resting on the point, in order to lessen its liability to be thrown out by a sudden jolt. For the same reason, the pocket should be deep enough to slightly overlap the widest part of the bob. The top, A'C', is an arc of a circle whose center is near B'.

When sewed together, the line A'B'C' coincides with abc, thus forming the pocket desired. The sizes and shapes of these pieces will, of course, vary with those of the bob, but patterns may be cut out of paper, and altered, until the desired fit is obtained.

In work requiring frequent use of the plumb-bob, the saving of one's pocket caused by the use of this little holder may repay the user, and it is certainly advantageous to have the bob always right-side up and easily withdrawn.

A REPORT OF

SOME TESTS ON BRIDGE TIMBER

WHICH HAD BEEN IN ACTUAL USE IN A BRIDGE TRUSS FIFTY-ONE YEARS,

AND

SOME NOTES ON PILE AND CRIB FOUNDATION

IN ACTUAL USE EIGHTY-FIVE YEARS.

By Edwin Dwight Graves, Hartford, Conn.

During the year 1902 the writer served as member of a Committee of the Court, for the purpose of determining the value of an old wooden toll bridge. This Commission consisted of one lawyer and two engineers.

Among the interesting points brought out by the testimony was the question of the value of sound timber which had been actually in use in the structure fifty-one years. Of course decayed timber was condemned at once, but an attempt was made by one of the parties interested to show by testimony that the sound timber was valueless on account of its age. The timber was old growth white pine, of excellent quality. It had been under cover and well protected during these years, and of course was absolutely well seasoned. The testimony of a great number of so-called "practical" men was directly contradictory, depending upon which side called them as "experts." The wood was characterized as "punkey", "wooley", "dosey", "lost its life", "brittle", "dead!", etc., according to the views of the different men; and also "as good as ever", etc., by the opposing side; all pure matter of opinion or prejudice.

In order to clear up this radical difference, we determined to make actual tests of this material on samples taken from the top chord, which chord was made up of two pieces 8x12 and one piece 10x12. Samples from several timbers were selected and sawed up and planed to one inch square and two feet long. A number of samples were tested at the laboratory of the Massachusetts Institute of Technology, and others at the laboratory of Henry Souther, of Hartford, Connecticut, on a 100,000 pound Seller's machine.

Tension Test:

The test pieces for tension were turned down to a section ¾ inch in diameter, for a length of 2 or 3 inches at the middle of the test piece.

7 samples at Hartford averaged 8,261 per square inch.
6 samples at Boston averaged 8,399 per square inch.
Average per square inch, 8,330 pounds.

Transverse Test:

Tests on bars about 1 inch square, resting upon rotating supports 12 inches apart, with a load gradually applied at the middle, give the following average calculated stress on the outer fiber at the breaking point, from the following formula:

$$f = \frac{3wl}{2bh^2}$$

7 tests at Hartford,	9,200	pounds	per	square	inch.
6 " " Boston,	9,820	"	"	"	"
Average,	9,510	"	"	"	"

The fracture in every case was tough and stringy and showed no signs of brittleness.

Compression

Tests for compression endwise the grain were made at both laboratories on samples one inch square and two inches long.

4 tests at Boston average	5,597	pounds	per	square	inch.
4 " " Hartford "	6,050	"	"	"	"

Average crushing per square inch lengthwise, 5,824 pounds.
Weight per cubic foot, 27.06 pounds.

The American Association of Railway Superintendents of Bridges and Buildings, in Report of Convention of 1895, recommend for the ultimate breaking stresses per square inch for white pine:

Tension with the grain	7,000
Compression with the grain	5,500
Transverse, extreme fiber stress	4,000

In Bulletin No. 12, U. S. Department of Agriculture, Division of Forestry, the values recommended for white pine by seven of the most prominent engineers average:

Tension with the grain	8,800
Compression with the grain	5,100
Transverse, extreme fiber stress	6,440

In the same report, transverse tests on twelve full-sized white pine beams in use thirty-one years gave an average stress per square inch of 7,000 pounds; and tests on two new white pine beams, full size, gave 5,400 pounds under the same tests.

Tests on bridge timber which has been in long use are rare, and there are very few expressions of opinion on this subject. It was, therefore, exceedingly interesting to the writer to have the opportunity of making such tests from material which had actually served as a part of a bridge.

The Committee adopted the results of the tests as a basis of value, and estimated the sound timber as being equal to new timber.

In the humble opinion of the writer, this old growth timber, when in good condition, is to-day worth as much or more than most of the new timber which could be found to replace it.

Referring further to the general subject of durability of timber in various conditions, the recent removal of the foundations of the piers of the old Hartford Toll Bridge furnishes interesting information.

This old bridge was built about 1818, and the piers and abutments were rough stone rubble masonry, apparently laid without much mortar except for pointing. The stone work rested on timber grillage bearing partly on timber cribs and filled with stone, and in some cases on piles very lightly driven in the sand and protected by riprap. The piles were short and small, 8 feet to 12 feet long and 6 inches to 8 inches in diameter, pointed with a very long, sharp point, and in a few cases protected by wrought iron shoes. When these piles were dredged out, the points even when not shod were sharp and perfect, showing absolutely no brooming or hard driving. In some cases these piles were cut off from 1 to 2 feet above ordinary low water and surmounted by a wooden grillage of hewn timbers, on which the stone pier was built. These grillages, even above low water, stood safely for at least eighty years. The piles when dredged out show the portion below ordinary low water absolutely perfect and sound. The tops of the piles are somewhat worn off, largely due to abrasion. In among these piles clear sand was found and only a small quantity of light riprap around the outside of the pier to protect it.

The two west piers, which were in the channel of the river, were evidently of a different type. In all probability hewn timber cribs of pine pinned together with oak pins were built and sunk to the river bed, and filled with loose stone to the top, and the pier constructed thereon. These cribs had stood perfectly for eighty-five years and when torn or broken up by the dredge, the timbers at once floated to the surface as lightly as new timber.

Samples of the white pine and the oak pins may be seen at the writer's office by those interested.

SPECIAL CONCRETE.

The best work, in any case, is the kind of work that accomplishes all the objects sought, at the least expense.

Late in the autumn of 1902 it was decided to raise the high-water level of a storage reservoir about four feet, requiring the enlargement of two dams and the construction of two others. The available time was short, the amount of work was too small and too scattered to justify the installation of a stone crusher, and suitable gravel was not at hand. Sufficient small boulders in old walls, and borrow pits and on surface of fields were available, and were used with thin Portland cement mortar to form the "special concrete" which is the subject of this sketch.

One part of Alpha or Lehigh cement and three parts sand were mixed dry at first and then wet with just enough water to make the resulting mortar flow by gravity. This mortar was shoveled into the forms continuously by one set of men while other men were throwing into the mortar in the forms the boulders which were cleaned and broken so as not to be more than seven inches long. In general the performance was continuous. Three mortar beds were placed parallel with, and against, one side of the forms, with spaces of about four feet between the ends of the beds. The boulders were dumped on the opposite side of the forms. Two men shoveled in all the mortar and did nothing else. While they were emptying one bed the mortar was being mixed in the preceding bed by two other men and the materials placed in the third bed by still others. Another gang were continually throwing in the boulders and small stones and still another were breaking stone.

One man should keep the mortar well stirred while the bed is being emptied. About 20 men were necessary to do all parts of the work.

The forms were of two inch planed plank tongued and grooved. Especial pains were taken to make the forms tight, and all leaks that appeared were quickly stopped with dry cement. Some pains were taken to prevent a flat side of large stones from coming in direct contact with the forms, but round boulders and small stones needed no care to prevent their showing in the finished work. The resulting concrete walls looked unusually well when the forms were removed, too smooth as a rule for plastering. When clean plank was used in the forms it was seldom that a stone showed in the face of the wall. The water side of the walls were painted with a thick paste of neat cement applied with a brush.

A considerable part of this concrete was used in raising the level of the original core wall, to reach which a trench five feet deep was dug in the dam. In puddling the backfilling of this trench two feet of water standing on the unexcavated side of the core wall failed to show moisture through the two-foot wall. Later when the rather narrow space between the core wall and the retaining wall was being filled with earth, a careless teamster would scrape the wall with an iron hub of a loaded cart. The polished surface of the resulting groove had a very satisfactory appearance.

Horizontal joints where work was left off at night were well broken by the projecting boulders purposely left rough. End joints were grooved by building in a piece of beveled scantling. None of the joints could be detected when the forms were removed.

In one dam the core wall was 571 feet long, 5 to 11 feet high, and uniformly two feet thick; 440 feet of the central part of this wall rested on a solid masonry wall built more than thirty years ago, and the remaining portion was on natural earth. This 571 lineal feet of concrete wall was built in sections at intervals from October 10 to November 4, and remained exposed until about November 15, and not a single crack appeared, either where the foundation changed from the old masonry to earth or at any other point. Two of the other dams were connected through a loose gravel bank by extension of the concrete core walls, making a structure 383 feet long, which was equally free from cracks when covered in, as was also the core wall of the fourth dam, which was 235 feet long.

It is believed that this method made concrete as impervious as that made by ordinary methods and perhaps more so, while under the circumstances mentioned the cost was less, and, more important still in this case, it could be put in faster.

It is to be regretted that no detailed account of the labor and material used was kept. Such concrete should not be used unless the work is in charge of conscientious, capable, and wide-awake foremen or inspectors. The essential points are even distribution of large and smaller stones and mortar, and thorough mixing and rapid handling of the mortar.

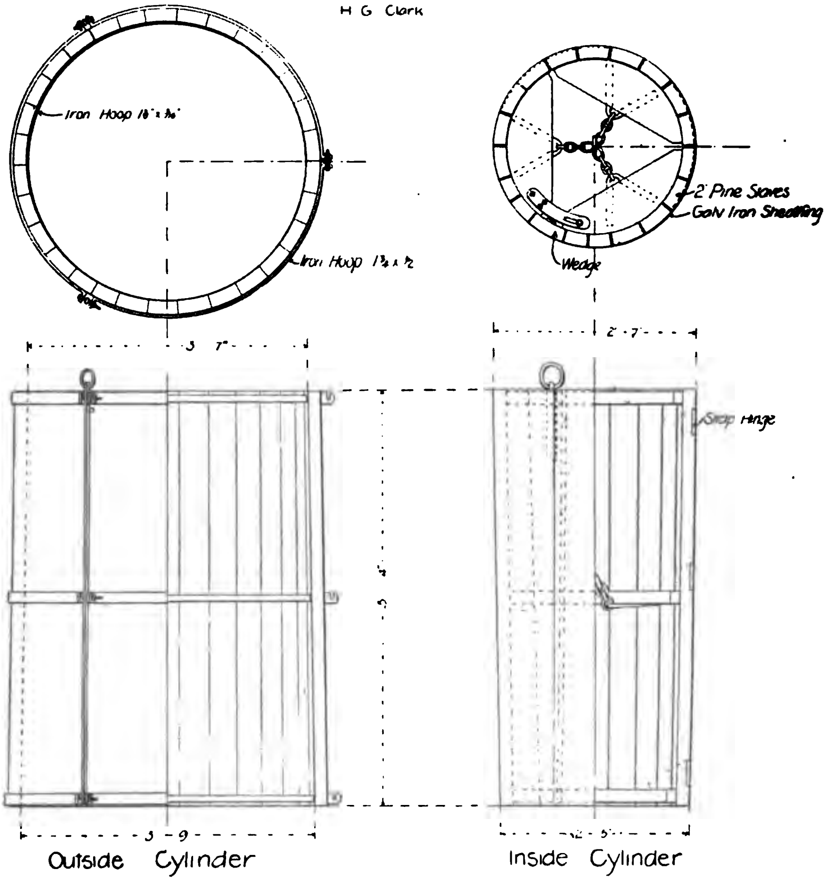
This work was done by the Hartford Paving and Construction Co., under the direction of C. E. Chandler and S. B. Palmer, engineers of Norwich, Conn.

DESCRIPTION OF FORM FOR CONCRETE CATCH BASINS.

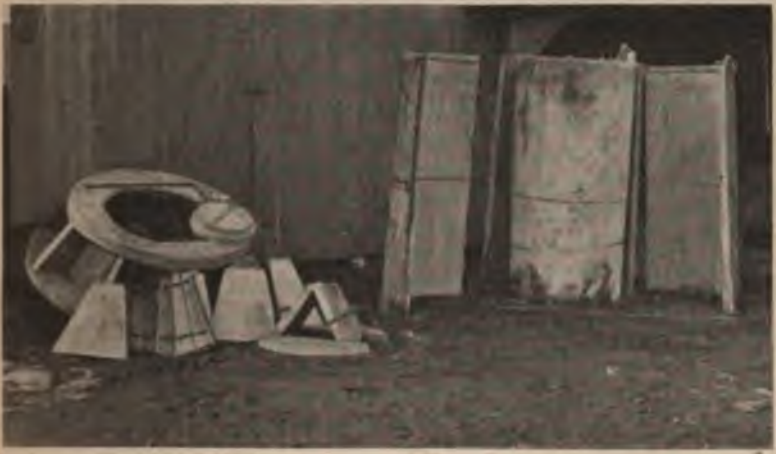
By H. G. Clark, Hartford, Conn.

The numerous brick catch-basins built on Keney Park cost about $25.00 apiece, without the castings. In order to reduce the expense and to make catch-basins which would not be broken up by frost, the writer constructed a form for making the catch-basin of concrete.

FORM FOR CONCRETE CATCH BASINS
Designed for use on Keney Park
SCALE 1½" TO 1' SEPT 1903
H G Clark



The apparatus consists of an outside and an inside cylinder. The outer cylinder is made of 2 inch pine plank, bolted to iron hoops, one at each end and one in the middle. The cylinder is divided into three sections, and is held together when in use by bolts which pass through slotted holes in right angle bends in the ends of each hoop and also through a vertical iron rod 1 inch by ⅝ inch standing between each pair of lugs on the hoops. The sections are bolted together and lowered into the hole and are removed in three sections by pulling on the lifting rods which lift the bolts out of the slots in the hoop lugs.



VIEW OF FORM IN SECTIONS.

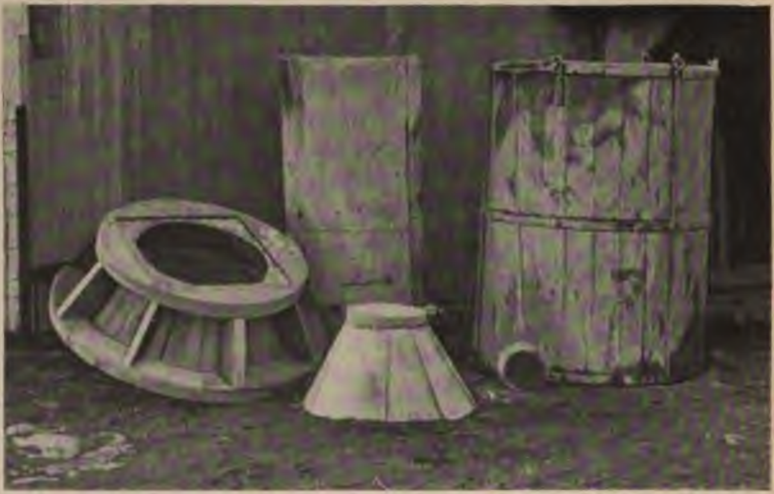
The inside cylinder is made of 2 inch pine staves bolted to 2 inch spruce circular segments, with ⅜ inch spacing between the staves to allow for swelling. The outside is covered with No. 16 galvanized iron, which presents a smooth and waterproof surface to the concrete. This cylinder is divided into three sections joined by strap hinges at two of the joints, while at the third joint is a wedge-shaped stave. To remove the cylinder the wedge is first drawn out, then the cylinder closes on its hinges and frees itself from the concrete.

Round wooden plugs are placed between the cylinders at the required level for pipe inlets or outlets.

To reduce the diameter of the top of the catch-basins a cone-shaped form is placed after the lower part is finished, and the concrete is filled in till the diameter corresponds to the casting to be used.

The outside cone is made in one piece, as shown in the cut.

The inside cone is made of sectional staves bolted to iron cleats and covered on the outside with galvanized iron, the alternate staves overlapping.



VIEW OF FORMS ASSEMBLED.

Twenty-six catch-basins have been built with these forms on Keney Park, at a cost of about $7,00 apiece for the concrete in place, or about $10.00 apiece including digging the hole, etc.

Brick catch-basins of the same size built by day labor cost $20.00 to $25.00 apiece without the castings.

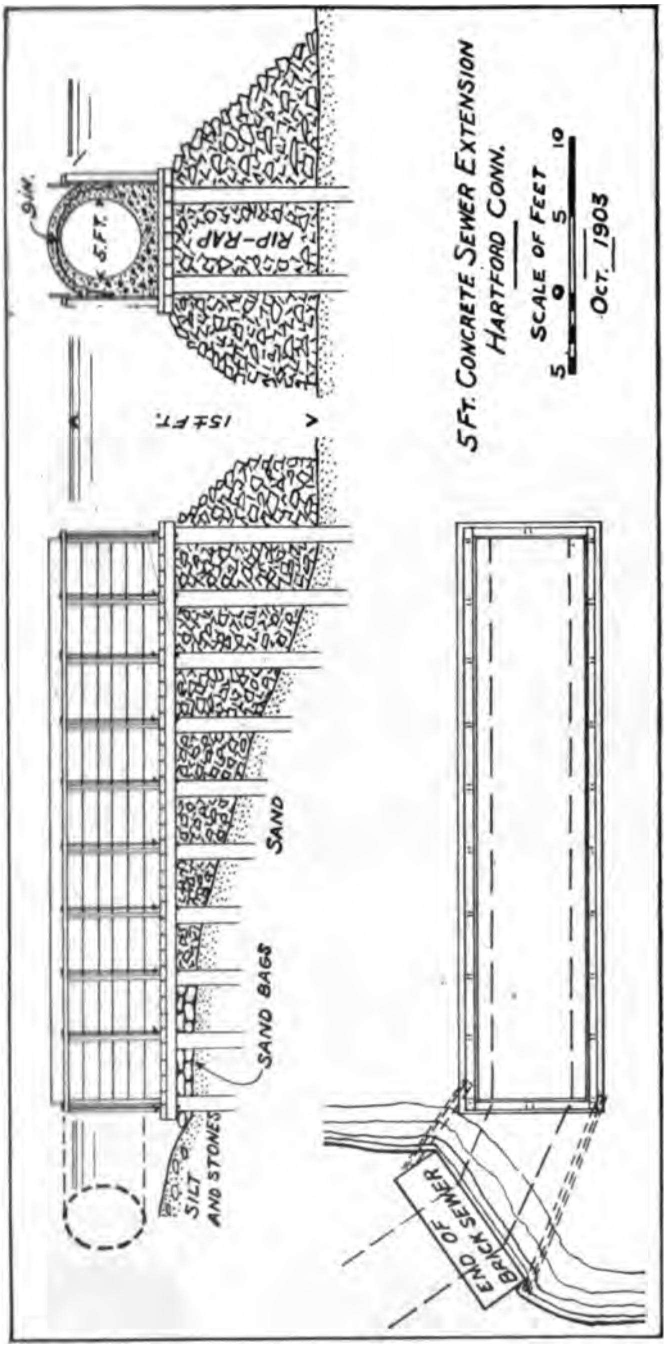
NOTES ON CONCRETE SEWER EXTENSION AT HARTFORD.

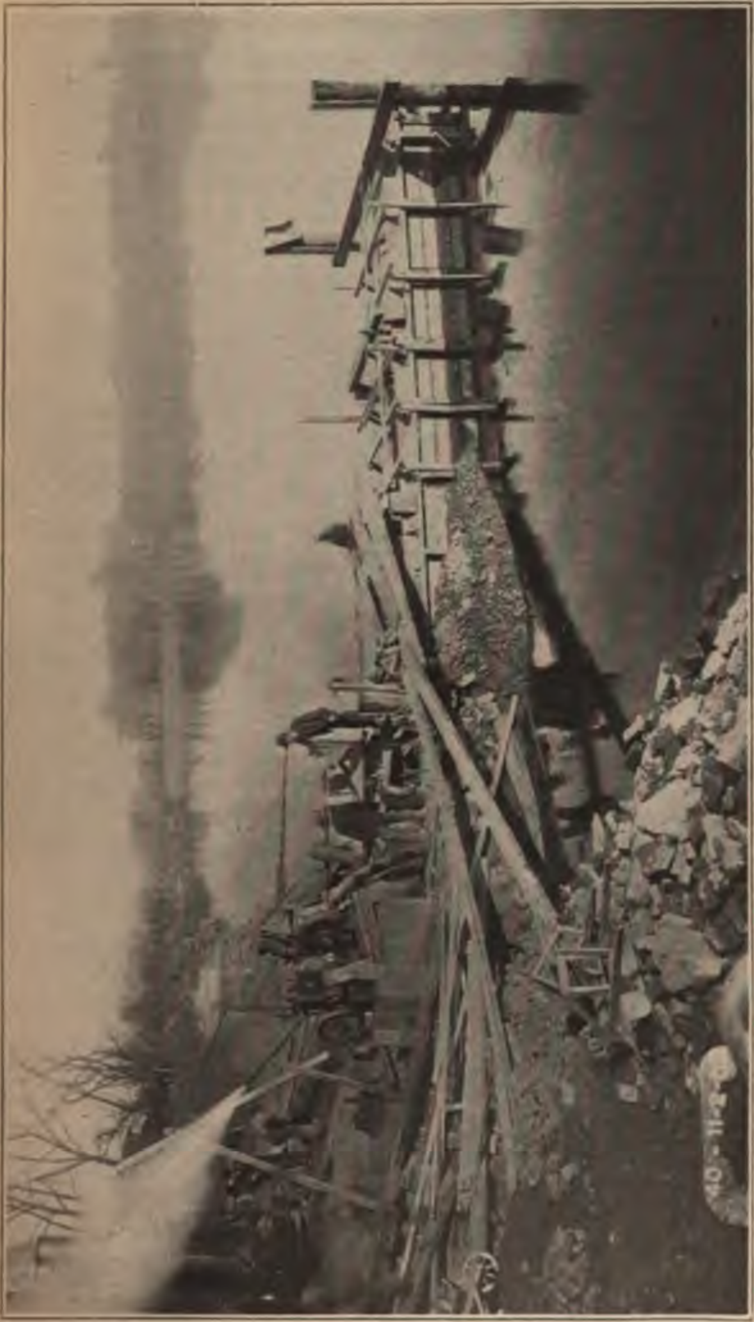
By Edward Wallace Bush, Assistant Engineer Connecticut River Bridge and Highway District.

In preparing a suitable western approach to the new stone bridge now being constructed over the Connecticut River, at Hartford, Connecticut, it became necessary to extend the outfall of the northeast intercepting sewer into the river a distance of about 42 feet. This extension was made in October, 1903, by the Connecticut River Bridge and Highway District Commission, Mr. Edwin D. Graves Chief Engineer, at a cost of about 40 per cent. under the lowest bid received for doing the work. As the method employed to construct this extension was somewhat out of the ordinary line of sewer work, a description of the work may prove of interest to the members of our Society.

The sewer extended was a 5 foot circular brick construction, having its invert at the outfall at an elevation of from 3 to 5 feet below the surface of the water at the ordinary low stages of the river. As the water at a distance of 42 feet out from the sewer was about 15 feet deep, a coffer dam around this point would have been uncertain and expensive, so it was decided to construct the greater part of the sewer in an open caisson, sink the caisson on piling, place an ordinary clay coffer dam about the shore end of the caisson connecting it with the end of the brick sewer; then remove the end of the caisson and build the missing portion between the new and old work.

The piling was cut off in the usual manner by a circular saw suspended in the leads of a pile driver. The bottom of the caisson consisted of a course of 6 inch yellow pine laid lengthwise, above which was a course of 4 inch yellow pine laid crosswise, and well spiked with 8 inch cut spikes. The sides and ends of the caisson were built up of 2 by 12 inch yellow pine, with each edge bevelled ⅛ inch, and were securely fastened to the bottom by ½ inch iron rods.


5 Ft. Concrete Sewer Extension
Hartford Conn.
Scale of Feet
5
0
5
10
Oct. 1903
9 in.
5 Ft.
Rip-Rap
15½ Ft.
Sand
Sand Bags
Silt and Stones
End of Brick Sewer



After the work was started several days of wet weather raised the river so much that the sides and ends of the box were raised an additional plank before the caisson was sunk on the piling. All seams were well caulked with oakum.

Before the caisson was landed, cement bags partially filled with sand were packed tightly around the piles at the shore end of the piling by a diver, to prevent water from passing under the grillage to the coffer dam to be built later. These bags proved very effective, as the total leakage into the coffer dam from this and other sources was but little.

All masonry consisted of Portland cement concrete, mixed 1 to 2 to 4, using 1 inch and ½ inch stone. The crown of the sewer was 9 inches thick and was reinforced by heavy expanded metal. The sides and bottom were not less than 12 inches thick.

A 6 inch centrifugal pump directly connected to a Westinghouse engine was run continuously during the coffer dam work to take care of the sewage flow. After the inside of the coffer dam was excavated the speed of the pump was reduced, allowing the sewage to come up to the same level as the water in the river and was maintained at this height until all of the concrete for the bottom half of the sewer had been deposited under water by means of a tube. This tube was an ordinary 7 foot length of 6 inch spiral riveted pipe, with an improvised hopper at one end. The pipe was handled by means of ropes fastened at the top and bottom. A considerable volume of sewage was coming from the sewer at all times and, if an attempt had been made to place the concrete anywhere near the pump suction, the concrete would surely have been very badly washed.

In placing concrete under water in this way the concrete should be mixed with fully as much water as would be used for concrete deposited in the open air. When the tube is first charged, there is a little concrete which becomes badly washed, but soon the water is forced completely out of the tube, and the rest of the concrete placed in the bottom in good condition.

In the latter part of the year 1900, the writer was engineer in charge of some work for the American Bridge Company, in which this method was used very successfully in placing the foundations for twelve bridge piers. The concrete in these foundations varied from 3 to 6 feet in depth. At some of the piers the deepest part of the excavation was 8 or 9 feet below

the surface of the river. After the coffer dams were pumped out, in each case, the foundation concrete was to all appearances fully equal to similar concrete deposited in the open air.

The writer recommends this method of placing concrete as being a simple, cheap and effective way of obtaining a good foundation in a wet bottom, and believes in many cases where concrete is being placed at the same time that heavy pumping is done, that a much better foundation may be constructed if the pumps are stopped until after the bottom has been placed through a tube.

The photographs and drawings herewith serve, to some extent, to illustrate the methods and work described.

GOOD ROADS.

By James MacDonald, Highway Commissioner.

Before proceeding to take up the formal part of my address I feel I ought, at this time, to offer a slight tribute of respect to a very honorable member of your society who has recently ceased from the active duties of life and passed over the river to the land from whose bourne no traveller ever returns.

About twenty-six years ago, in my young manhood, I became acquainted with James P. Bogart. I was then just started out to earn a livelihood at my profession, a young man in a strange place without many acquaintances, very little money, and few friends. I was requested by a large corporation to present a bid for some work that had been arranged to be done. In competition with others my bid was the lowest and I was awarded the contract. After I had been at work upon the contract about a month I discovered a very serious mistake had been made in the survey under which I had secured the contract. It was a serious mistake to me and acknowledgment of the mistake meant a great deal to the engineer in charge of the work. When the matter was presented to Mr. Bogart, under whose direction the engineering part of the work was being done, and a decision asked for, he immediately said: "There has been a mistake and Mr. MacDonald is entitled to the benefit of every doubt in regard to this matter." That decision, in my judgment, was the hinge upon which my whole future career hung. It involved several thousand dollars. It meant very much to Mr. Bogart to acknowledge this mistake. He was not to blame himself, for the mistake had been made by one of his assistants. But it was a manly thing to do. It meant to him, perhaps, loss of business; to me it meant all I had in the world. And I felt that at this time before such a company of gentlemen, men that associated with Mr. Bogart in a professional way, who knew him intimately and personally, and who are following the same line of business, the relating of this little incident by a man who feels the most intense gratitude for the honorable way in which he was treated, might act as an incentive to others to "go thou and do likewise;" and I do not mean by this that any member of this honorable Society would have acted differently, but I wish to state that the temptation was strong, he being a young man just entering into active work in his profession, to have made some excuse or in some way shifted the responsibility. However, on the contrary he very manfully acknowledged his mistake, when the matter was presented to him, and set the whole matter right in a moment's time. And I feel like saying to-day, "God give us men in times like these; men of strong minds who will not stoop to please."

An honorable career has been closed; the life's history of this man has been written; all through his private life or his professional career James P. Bogart was a man whom everybody knew to love and respect. And when he passed away he went "not as the quarry slave lashed to his dungeon, but rathei like one who wraps the drapery of his couch around him and lies down to pleasant dreams." When he breathed his last breath the state of Connecticut lost a good citizen, his wife lost a devoted husband, and every friend knew there was an irreparable loss to him when James P. Bogart was removed from his acquaintance. Of such lives it can be truly said that "You may break, you may shatter the vase if you will, but the scent of the roses will cling around it still."

Six years ago I addressed this honorable Society. 'It was just when the Good Roads movement had been taken up as an experiment; very few either in this state or in any state knew very much about the art of road building. The character of the work that had been done throughout the municipalities and in the country towns of the state was not such as to call any especial attention to its quality or durability. Indeed in only two states had the subject of road reformation been taken up under a state aid plan, first New Jersey and second Massachusetts. There had been no time to investigate, and indeed if an investigation had been made the result would have given very little satisfaction in regard to a preparation for any commission to take up this great work in our state. In Connecticut the system of road building was varied in the extreme, ranging from the simplest method that had come down from primitive days, to macadam, as understood at that time. It was a groping in the dark with practically nowhere to go to for light and lay hold of a ripe experience and get a practical knowledge of that which was required or necessary to be done.

The commission at that time fully understood this at their first meeting and were appalled at the magnitude of the undertaking. Not a single member of the commission knew practically anything about the conditions by which the towns of the state were surrounded, except that knowledge which he had of the roads in his own town. Old customs were still in use, which carried with them deep-seated methods that would require many years of education and the expenditure of a large amount of money before the towns of the state would begin to appreciate that the methods employed, the evils that existed, were wrong and that reformation was necessary.

The commission immediately set to work to get all the information they could acquire in every possible way. The state was divided up into three districts so that a more intimate personal acquaintance might be had of what was best to adopt in the way of a system to be employed by the highway department in the distribution of the money placed in our hands so that it might be expended intelligently and economically, and establish a permanent improvement in the highway system.

I need not say, gentlemen, that the first two years were very anxious moments, for upon the foundation of those first two years was to be built a system upon which rested the success or failure of highway improvement in the state of Connecticut. The law under which the commission was at work had never been tried. It had been built entirely from the necessity of having some definite plan under which to operate. It was not claimed by its promoters that it would meet every exigency that might arise; it was simply a law under which something might be developed that would lead up to some intelligent plan under which the state aid could be intelligently applied to the conditions as they existed at that time. Since the first law many changes have been made, but it is an astonishing fact that gentlemen who were not supposed to be constructively wise in regard to highway improvement could frame so wise a law with so little experience with this great question. The original law of 1895 has been modified somewhat in some instances and extended or enlarged in others. But the principle of paternal interest in giving over to the towns of the state some assistance to enable all towns to take up this great question and operate it successfully under a wise and helpful plan are still permanent features of the existing law.

The State Board of Trade deserves the lasting gratitude of the entire state, not only those who are taking an active part in the affairs of to-day, but those who are to come after and take up the burdens that will be laid aside by their fathers. Truly the State Board of Trade builded better than they knew by the introduction of the law of 1895.

After having now been in active operation under a state plan during nine years, it is safe to say that for general use reaching out into and grasping fully the situation, the present law is very nearly perfect in its operation. Mistakes have been made many times, no doubt, in bringing into active operation the present system under which roads are improved with state assistance. These mistakes have been very profitable, and have up to the present time taught us a great deal. It is impossible to make any law to meet a condition untried and adequately take care of all it was intended to protect or assist. It has been no light burden or responsibility for the highway department to take up this great question with all the difficulties to overcome and the obstacles in its way, and then successfully carry out a system to a perfect conclusion.

As evidence of the fact, however, that the present law under which we are now making improvements in the several towns of the state is satisfactory to nearly all the people of our commonwealth, it is only necessary for me to say that when the final day came for receiving applications for a part of the last appropriation, for the first time in the history of the movement in this state every town had applied up to that time for state aid. It has not always been possible to have every town agree with the policy of the Highway Commissioner's department. It was not expected that it would be possible to do so; but the fact still remains that the entire state of Connecticut as a whole is anchored fast to the plan under which the state is working at the present time. Amendments will continue to be made from time to time as new conditions arise and the minds of the people undergo a change in regard to highway improvement. There has been no attempt at all at making any extraordinary improvements. A simple plan has been adopted from the commencement of the work and continued down to the present time, under which every town, no matter how strong or weak financially, could participate and enjoy state aid. The desire of the department has been to, as nearly as possible, adopt a plan that would be generally approved so far as that result is possible.

The wide range of highway improvements taken in the state has been such that the towns have very pleasantly accepted the methods employed and are working in splendid coöperation to-day with the department. Many times there might be a question of where the money should be expended in a district in the town. Other times a question has arisen in regard to the character of the work to be done. But all of these matters have been adjusted in a way that has not been suggestive at all of any arbitrary manner on the part of my department. However, just so long as human nature is human nature, and we find it just as prevalent in America as it is in Africa, men will always desire to have roads improved in front of their own house rather than of their neighbor's. It is not a question of working out a new plan, but it is a deeper question than that, and reaches further; it is a question that extends back for hundreds of years into early methods, descending down from father to son through many generations. These things cannot be uprooted in a day and will take many years before an absolutely perfect system can be worked out in the improvement of the highways of the state of Connecticut. Therefore, the day has not dawned as yet when we can take up and make paramount the question of refinement of grade, the quality of stone best to be used, scientifically testing abrasion, road and property, also the question of maximum and minimum grade to be established, the solidity and durability of the construction of bridges, or indeed any of the elementary processes of the most refined art in road building. But it is safe to say that there has not been a single improvement made in the state of Connecticut during the past nine years, but what had in its purpose the laying of a foundation leading up to the very best and highest achievement to be had in permanent road-building in this state. The rude crushing of a stone lying in the middle of the road from its slumbers of hundreds of years, had in the act an emphasis of the thought of the commissioner of what the ultimate use of this highway was to be in the future. There is not a curve that is flattened in the changing of the direction of the road, or an inclination that has been reduced, or a culvert that has been put in its position, but has not in that treatment a thought many years into the future, that this improvement, modest, unassuming and inexpensive as it may be, has for its purpose the ultimate improvement of that road under the very best plan that the engineering art can bring to bear upon the question.

In looking back during the years that have elapsed since the commencement of state aid and the methods employed and adopted in dealing with this great question, the sentiment shown to-day throughout the entire state demonstrates the wisdom of the policy adopted. Not many towns in the state of Connecticut prior to 1895 were noticeable by reason of the fact that the roads of the town were so much improved and very pleasant for travel, but more from the fact that the roads were noticeable for their impassibility or poor condition so far as pleasant travel was concerned. It was rarely that favorable comment was heard about the character of the roads of the state, while to-day commendation is heard quite generally in regard to the great improvement that has been made in the road system of the state since 1895. Many of you gentlemen present to-day have been acquainted with the methods employed and have had charge of sections of highway that were improved under state aid from the first commencement of the movement down to the present time and can testify to this fact.

I must say in all fairness, and from a full knowledge and just appreciation of the work done by engineers, that you are entitled to share equally with the Highway Department in the progress that has been made during the last nine years. I know of no Society of the honorable profession of which you are members who have done more and better work than has the Connecticut Society of Civil Engineers in assisting to bring about this great reformation, which is apparent to every one in the state to-day. It is a delightful privilege accorded me to-day of meeting so many with whom I have been officially connected in the work of my department. I rejoice in the fact that I am able to say I appreciate what you have done, and thank every member of this Society for the valuable assistance you have been to me in my official work. We may have had some pleasant disagreements in regard to some particular feature of the work. But I can safely say from the consideration shown me so many times that I think I enjoy the confidence and the esteem of every member of this Society, whether we may have had some pleasant differences or not. It is quite natural that upon all occasions and at all times we would not agree. The years we have been co-laborers have grown a strong interest one in the other and the past years have been years of profit to us all.

It is a difficult matter, I find, to reconcile at all times the facts in regard to road treatment. I presume one of the most stubborn business encounters in a professional way that has ever occurred in road improvement was the controversy between John Macadam, the father of the macadam system, and Sir William Telford, the inventor of the telford construction. One claimed it was not necessary to do anything but under-drain a road and apply an ordinary treatment laid in courses of broken stone without any necessity for a foundation of stone upon any section of highway, going so far as to claim,—and in this he was supported by other men who were wise in road construction in their day and generation,—that it was not necessary to put in a heavy foundation of stone under a macadam treatment, that by so doing the life of the pavement was shortened. Sir William Telford, however, claimed, and had many adherents, that it added to the life and durability of a road to put in a treatment telford under the macadam. Both of these gentlemen, however, we have all lived long enough to learn, were right. But each method had its limitations to which these gentlemen might go with their claim and then they both had to stop and acknowledge the other was right. Just so long as grass grows and water runs, men will differ in regard to the treatment of every question that comes up. This shows us very plainly and emphatically that no man that has ever been born of woman can claim to know it all in everything. Indeed the wisest minds have time and time again stated, the longer they live and pursue any avocation the more conscious they become of their shortcomings. I think it is well for us all to feel this in our work. Indeed the statute of limitations is always measured by the little span of our lives and the mental ability we have to grasp situations. In all books in print to-day very few there are but what have been superseded, except that grand book of all books, the Bible, by something in keeping with the popular mind as it operates to-day. Tastes and temperaments change; the ideas of to-day are found not to provide for the exigencies which may arise to-morrow. We are all, no matter how old or wise we may be, simply going to school. The evolution which the world is undergoing to-day (except we confess that we have reached the limit of intelligence) is one of progress and advancement.

I think it is safe to say, and I believe you will all bear me out in the statement, that in so far as engineering is concerned, science, mechanics, or any of the other great branches to which the human mind is adapting itself or taking up as a life pursuit, that the trend is toward specialism. Hence, in the work we are engaged in of road-building it is destined to become a specialty. Men are being sought after far and wide to-day who are scientifically wise in regard to this fast coming issue of the hour. The whole United States is rising up almost to a man, state after state is inquiring about the best methods of construction and looking for the best man money can secure with the object in view of having the very best system to be found in the improvement of the highways of the country. With the whole question taking as it does the wide range of city streets, with its numerous pavements that have come and gone, and all of which have proved to be inadequate to take care of the traffic they were called upon to bear, compel the brightest minds of the country to seek after the best methods and the best materials with which to improve the streets and highways of the land. I know of no branch of the engineering profession which has such a promising future for a young man to take up as this work of highway improvement. In the time at my disposal I cannot touch upon very many important feature of road-building. But there is one I think it best to speak of at this time.

I have often been asked the question, what is the maximum and also the minimum grade allowed by my department. This question has been asked so many times that I deem it of sufficient importance to dwell upon it for just a moment here. The maximum grade the state would advise, if conditions would allow us so to do, is a 5 per cent. grade; and a minimum grade of 1 per cent. In both instances we have to depart from this rule. It is a difficult matter for engineers to understand, who are located in our large cities and are many times forced into a two-tenth grade as the minimum grade upon which to carry the water to the outlet, why it is that the state rather advises a minimum grade of 1 per cent. The simple reason is that on an earth gutter the wash from the road is continually coming down from the shoulders and filling the gutter line, and water running sluggishly will not find its way to the outlet on a less than 1 per cent. grade. Litter, consisting of leaves, branches of trees and all kinds of vegetable matter close up the gutters and make them almost impassable for the water. City streets are, as a rule, more carefully taken care of; sewers are flushed out and the gutters cleaned; while with the average country road very little attention is given gutters except during the cleaning times in the spring and fall.

Another reason for the establishment of this per cent. of grade is that the center line carries with it the same grade as that established for the water. The roads of our country towns are many times neglected, and where they are made of gravel or earth, or even a neglected macadam, they quickly respond to toe marks and ruts. No matter what the cross slope may be, these ruts will not clear themselves after a rain without an assistance on the longitudinal run of the road. Water lying in these ruts quickly responds to travel and these bad conditions are exaggerated. Hence, the road is made more dry and its life added to by clearing these ruts and toemarks from water as quickly as possible down to the exit point.

It is a difficult matter to have this understood without a careful investigation and study is made of these conditions as we find them in our work in the several towns of the state. Hence the minimum grade of 1 per cent. has been established and found to assist in adding to the longevity of the road.

The maximum grade of a road fixed at 5 per cent. is not a very great inclination. Many times we reduce this grade when we can without adding materially to the expense, for by so doing we are saving both time and money not only for to-day but all time to come. In other words, starting at 1 per cent. we make as convenient a grade as it is possible with the money we have at our disposal in the making of the improvement.

Many times it is impossible to go below 7 feet to the 100 without going into a very large outlay of money. The grades are so placed, however, that the future improvement of the road is not denied but rather helped. I think it is safe to say that the rule is quite rigid in regard to placing our most expensive pavement, namely macadam, upon any road. The decision of the department where grades exceed 5 per cent., or at the most 6 per cent., is not to lay macadam. Many times engineers work at a great disadvantage, being employed by the town, in giving to the road that intelligent treatment that the road would suggest, by reason of the fact that the selectmen of the towns are compelled oftentimes to extend work to a somewhat greater distance than the very best work would suggest by reason of the fact that the townspeople themselves desire to extend the improvement just as far as possible. It seems to me that they oftentimes make a serious mistake in their desire for length of road rather than quality. The engineers then have practically no voice in the matter and I have had engineers say to me, "Commissioner, I'm glad you suggested a further reduction on that grade." They would have done so, but the selectmen desired to have the money go as far as possible.

I am satisfied, however, since I have been going over the different sections of work in the state, that some other system than the one now in vogue in regard to the engineering work must be adopted before we can reach the very best work in the way of highway engineering. Of course, it is a difficult matter to accomplish everything as rapidly as we would like to do. These things have to be taken up and slowly but surely grown into an intelligent understanding of this great question. Indeed it is not always in a town government that an engineer finds obstacles in his work; we often find it in our large cities. There we find the work is often retarded and hindered by the political complexion of things and also personal interests. Engineers are displaced from offices where they have been giving excellent satisfaction to the public by reason of changes in the political aspect of the city government, and the departments are made to a very large extent, oftentimes, a question of choice. Just so long as this state of affairs continues our cities must expect not the best and most conscientious effort of the engineer in his work. No man can have his hands tied in carrying out matters and things in a municipality and give to that city his very best work in the engineering line. How often we find the most flagrant violations of engineering rules and wonder how such things could be done; but if we were on the inside we would find that the treatment in that particular case was not the best the engineer could give but rather was his treatment under the circumstances by which he was surrounded.

One of the most gratifying features in my work in the state is that while we have expended one million, nine hundred thousand dollars on the part of the states and towns in the improvement of the highways, it has resulted in the improvement of nearly 500 miles and these roads are standing the wear and tear of travel splendidly, while not 90 per cent. of the towns in which we have laid a macadam system sprinkle the roads or give them any especial care; yet they are standing up under the travel wonderfully well and doing good service. The towns, as a rule, in the state to-day, are taking a wholesome pride in their work. The shoulders are being carefully pared down. The gutter lines are being kept cleaner than ever before. The mouths or exits of the culverts are being cleaned out and the necessary repairs made. But better than all this is the fact that we find these object lessons have resulted in a general care-taking of roads outside of the state jurisdiction, those that do not come under the control of my department supervision. The question is often asked me in my travels, "How do the roads of our town compare with the roads of other towns?" And sometimes it is in the way of an apology that they call my attention to their roads, many times claiming they have the worst roads to be found in the state. And I am only too happy to say to these towns that their roads are not by any means the worst ones to be found in the state of Connecticut. This pleasant rivalry seems to exist in the towns, and it is certain to result in a splendid system of highways throughout the length and breadth of Connecticut. It is safe for me to say that not only has the state built 500 miles of capital highways, but the towns of themselves have put into splendid condition fully a thousand miles of highway without any assistance on the part of the state.

I feel, gentlemen, that these facts are perhaps as important to relate to you to-day as anything I might say, because you have been co-laborers in this movement and I know from the hearty interest you have manifested what I have told you will be gratifying information to you. Coming as it does from the commissioner whose privileges are perhaps greater than others to investigate the conditions of the roads in the several towns [illegible] statements [illegible] in the future.

It is a matter of great gratification [illegible] know that the [illegible] Massachusetts [illegible] high [illegible] their profession, as [illegible] that the engineers [illegible] of the [illegible] their charge [illegible] [illegible] commissioners buildings as [illegible] importance to secure the attention of the management of the Consolidated Railroad, whose president openly stated a short time ago that he would have the tracks removed so that the improvements suggested could be made and the beauty of our capitol and its magnificent surroundings enhanced thereby. I believe the suggestion came first from your president, Mr. Ford. This of itself should call attention to the work of the engineers of this Society in no uncertain way.

Another member of your Society is Mr. Fayette L. Curtiss, chief engineer and fourth vice president of the Consolidated Railroad, who has climbed the ladder of official fame in the arduous and trustworthy duties of his position. Step by step through his worth and wonderful engineering skill he has reached the pinnacle of fame and engineering prominence, not only in his own state but also throughout the United States, by reason of the splendid work he has done along the line of railroad engineering. It should be considered a proud position on the part of your Society to have such men enrolled on your list of members.

Another gentleman whose name stands on your roster is Mr. A. B. Hill, whose long years of careful training in the city of New Haven in full charge of all its municipal work have made him occupy a prominent place in the profession. Since resigning that position he has taken up electrical engineering and the building of trolley roads. No name stands higher when an engineer's services are required than the gentleman I have spoken of.

The stupendous details and carefully thought out plans of the new Hartford bridge will always be a monument to a member of your Society, Mr. Graves.

Mr. Punderford, having worked his own way up, deserves to be specially mentioned for his energy, his engineering skill for having placed himself in the position he now occupies to-day. I am glad to see you have honored him and yourselves to-day by electing him as your next president.

I could go on for an hour and enumerate here the names of the men who are members of your Society and who are prominent in their profession, but time forbids.

In closing, gentlemen, I wish to say we are to have to-morrow and the next day here in the Assembly Chamber of the State [illegible], the largest convention of its kind, not only ever held in the United States but the largest of the kind ever held in the world. Men are coming from all over the United States and are coming back to the banks of the old Connecticut River to talk about good roads. Some of them are direct descendants of those old settlers who went out from the old plantation on the banks of the Connecticut. The entire population of the city of Hartford is responding today and they are going to do something that has never before been done in the history of this city,—they are going to give a magnificent banquet to 1,000 delegates. The trolley lines of the city have been thrown open so that the delegates may have free rides and thus see our beautiful Hartford. The Elks have thrown open their magnificent home and will entertain the delegates there.

I invite each and every member of this Society to act as a delegate and participate in all the measures and proceedings of this convention.

A NEW WATER POWER IN CONNECTICUT

By Walter Scott Morton.

The inception of the water-power development, the subject of this paper, goes back into the nineties, when the Honorable Nicholas Staub, of New Milford, secured a charter from the Legislature of Connecticut authorizing the construction of water powers on the Housatonic river, under the auspices of the New Milford Power Company.

In the modern use of water powers, involving, as a rule, electrical installment and transmission, small powers are valueless, except when used at the place of development. The necessary installation of expensive electrical equipment and costly transmission lines require large incomes to warrant the outlay.

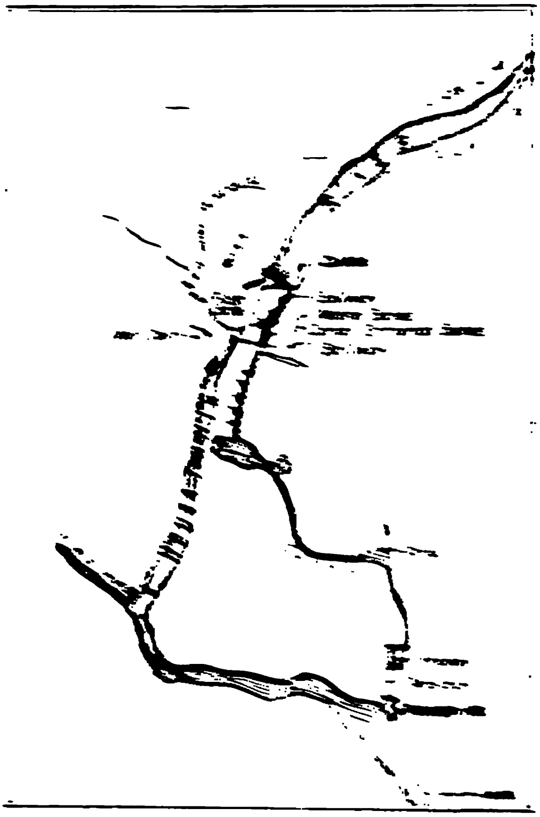
The Housatonic river, viewed as a power-producing stream, was not commercially attractive unless a high head could be obtained, and that this proved to be feasible at Bull's Bridge made the present development a desirable and, in view of the present status of water-power development in Connecticut, or electrically considered, in the New England States, a notable one.

The river from the selected dam site at the head of a narrow, short, rocky gorge lying about four miles below Kent, to the power house, over two miles below, is a series of small falls and rapids, almost continuous, the largest, Bull's Falls, so called, being but a few hundred feet south of the dam.

Forty-five feet of the total fall is accomplished in the upper 1,800 feet, which, with the 15-foot dam, would give a head of 60 feet, and was of comparatively easy development.

This was not considered sufficient, however, to warrant construction, and it devolved upon the writer to, in some way, encompass the additional fall below this point in order to make the proposition attractive.

The banks of the river below the gorge at Bull's Falls, while high, were still many feet below the established flowage line. The problem was finally solved by tracing out a canal along the eastern hillside which, fortunately, was found to be posside. Nature had also amply provided a level plateau just above the power-house site suitable for a forebay and at the right elevation an excellent location for the power house and deep water in the river for the tail race discharge.



[illegible] outline [illegible] structures and [illegible] conditions.

[illegible] development. [illegible] are of comparative greater strength, and high heads practically eliminate the fluctuations of the river between low water and flood in their influence upon the power output. The vast power going to waste on the Delaware and Susquehanna rivers could be profitably utilized were it not for the fact that low heads only are obtainable, which the floods absolutely drown out.

The development, briefly stated, consists of a concrete dam, without openings of any kind, waste gates in the canal debouching into the river below the dam site, head gates, a flush gate, a high water "run-around" protected by a rock-fill dam of novel construction, two artificially created reservoirs in the line of the canal, a forebay of ample capacity, a concrete entrance chamber for the pipe inlet containing racks and suitable gates for controlling the water, a steel riveted penstock, 13 feet in diameter, and of comparatively short length; a commodious power house, constructed entirely of concrete and steel, containing the necessary hydraulics and electrical equipment. In addition, unusual length of spillways for the automatic control of the canal and reduction of flood level in the pond above the dam.

The river above the dam being comparatively flat, is turned into a fine storage basin for a distance of nearly 4 miles and is of great value.

The upper portion of the canal was first excavated so that the waste gates and head gates could be erected, and the river, during the construction, turned through this portion of the canal to avoid placing any permanent openings in the dam, which would necessitate the reduction of its spillway length. This part of the canal, starting some 30 feet easterly from the dam site, skirts the river. It was made through a thorough rock cut from 18 to 40 feet deep. The waste gates were located 550 feet below the dam site, a natural depression in the rock formation at that point being taken advantage of. Also here was blasted out of the solid rock an entrance chamber for the canal proper, in which is contained the waste gates, a flush gate capable of being lowered to relieve the entrance chamber of floating debris and ice, and the head gates. No racks were installed at the entrance gates, as they were unnecessary, the canal entering an artificial lake some 1200 feet below, which takes care of any floating debris which might pass the entrance gates.

The form given for the face, or down-stream side, is that of the parabola for the top curve, calculated with water 1 foot over the crest, assumed to be the mean head, and the reverse curve a cycloid, the curve of quickest descent. The face of the Holyoke dam is of similar design; the back of the dam is vertical from the foundation up; the foundation of concrete, interspersed with large stones, being off-set 1 foot up stream, and upon this offset were placed the forms for moulding the dam proper.

A very sharp arch form was given, the radius on the back side being but 109.6 feet. The ends were flared at their junction with the rock ledges to give greater resistance in arch action. That concrete and masonry have some elasticity, so that arch action does take place, is agreed upon by the best authorities, but to what extent, and how dependable, is uncertain. Two notable examples of dams built where the section is materially less than that required for gravity are found in the Bear Valley dam and the Sweetwater dam, both in California. These dams depend on arch action for their stability and are respectively 64 and 90 feet high, but of short length. The Zola dam, in France, is also an example of this type of dam, and is 123 feet high, with a base only 41.3 feet. It has a radius of curvature of 158 feet. But engineers generally have not followed this practice, except that the arch form is given where the length of the dam is short.

In the calculation for the Bull's Bridge dam the arch resistance was ignored and the strength figured as though the dam were straight; but the arch form given undoubtedly adds very materially to its strength and makes the factor of safety six or seven times the overturning moment.

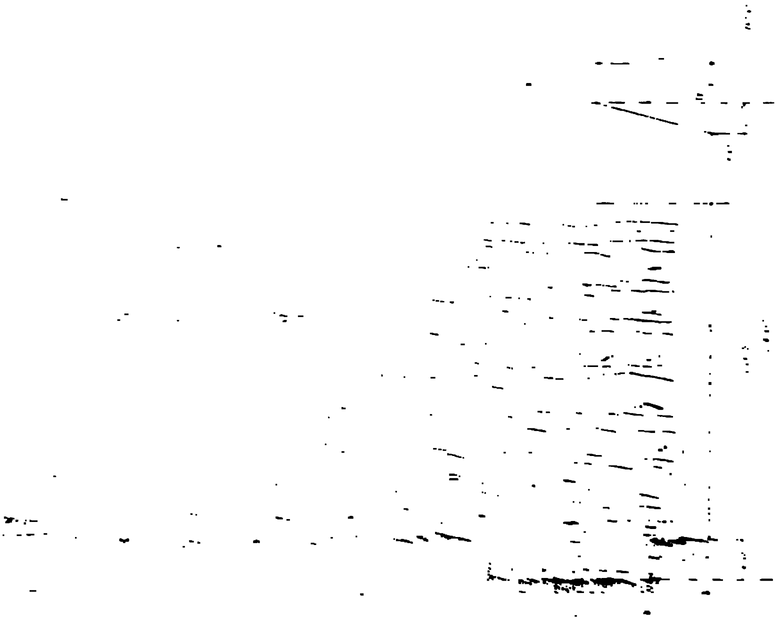
The resistance for overturning on the gravity section shows the resultant moment well within the middle third section, the water pressure being culculated with a head 8 feet over the crest of the dam—a condition hardly possible.

The section hereto attached shows clearly the shape and dimensions given.

For construction purposes a cable was erected over the dam site. The concrete was mixed on shore and delivered in half-yard wooden skips. By means of the cable it was also possible to handle stone of large size, to be imbedded in the concrete.

No stone was allowed to be placed nearer than 2 feet to any surface of the dam, nor nearer than [illegible] feet to the [illegible].

[illegible] concrete was mixed [illegible] a good quality of sand was obtained near [illegible]. The stone for crushing came partly from the [illegible] partly from the local stone. The run of the crusher was allowed, the dust being screened out. The cement [illegible]



[illegible] standard [illegible] Ameri- [illegible] the same. [illegible] and [illegible] mounted [illegible] consisting [illegible] of [illegible] comparison [illegible] The weight [illegible] with [illegible] the briquettes were broken by slowly pouring shot into a pail suspended from the end of the long arm of the lever. The specifications called for the following tests:

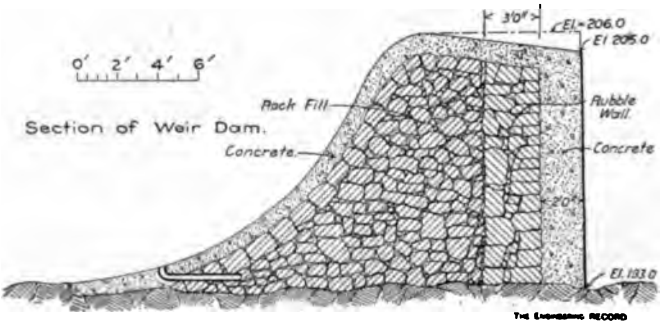
TEST CEMENT.

1 day in water, 200 lbs. per sq. in.
7 days " 200 " "
28 " " 600 " "

3 parts standard sand to 1 of cement.
7 days in water, 100 lbs. per sq. in.
28 " " 160 " "

Stress was applied at the rate of 400 lbs. per minute, and the briquettes in all cases left under a damp cloth in air for one day, or for sufficient time to thoroughly harden. The tests showed the cements to run from 25 to 75 per cent. above these requirements. In fact, upon stated specifications, it is reasonably safe to purchase cement from the standard companies in this district without rigid testing, as the reports of the companies themselves can be relied upon. All surfaces of the concrete structures throughout the entire work were plastered with a cement mortar 1 : 2 and 1 : 3 where exposed to the water. This is strongly advisable and adds materially to water-tightness, no matter what the thickness of concrete may be, but must necessarily be applied in warm or moderate weather, as plastering laid in freezing weather will always be doubtful. The back of the dam was plastered ½ inch thick with a mixture of 1 : 2. The top foot of the dam was made granolithic, to better withstand the erosive action of ice and debris. It was made of 1 part cement, 1½ sand, and 1½ carefully screened pebbles. The sides and bottom of the waste-gate openings were also lined with this same mixture, and after three months of wear from the entire Housatonic river showed no abrasion whatever. Masonry laid in cement mortar, but 2 feet in thickness, heavily faced with cement mortar, showed no leakage.

One of the unusual features of this work is found in the large length of spillway and weirs to take care of high water and protect the canal; the total length, including the dams, dykes used as spillways, and the especially constructed overflows have a total length of 1080 feet, amply safeguarding the canal and greatly reducing the height of flood discharge. Of this amount the dam furnishes 200 feet, in round numbers, the rock-fill dam before mentioned in the run-around, 130 feet, the spillway in the line of canal from the waste gates north, 200 feet, in the canal from the entrance gate south, 300 feet, and in the first reservoir below the dam 250 feet. In addition to this, and not included in the above figures, is the spillway at the north end of the forebay. Also, to take care of the flood discharge, are the waste gates having an area of 160 square feet, and capable of discharging, with the water a foot over the crest of the dam, nearly 4,000 second feet. The spillway areas above the entrance gate are sufficient to take care of the ordinary spring flood discharge of the river, with water only a foot over the crest of the dam.

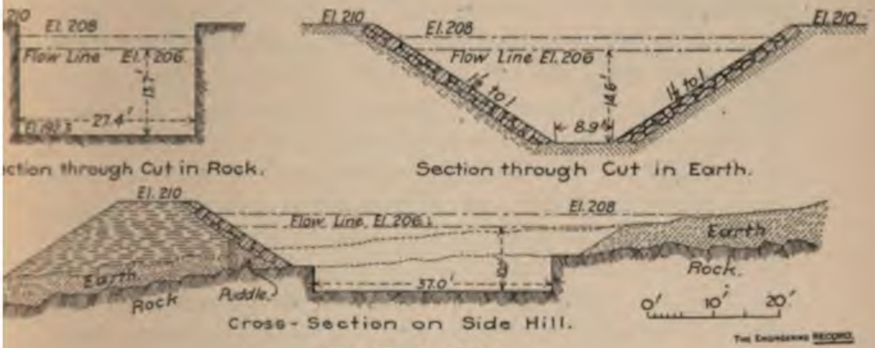


THE ENGINEERING RECORD

A unique feature of the development of this power lies in the high water run-around before mentioned.

A valley lying some 15 feet above the river bed encircles the dam site and enters the river some 1,200 feet below the dam, through a narrow gorge. This was taken advantage of and a dam built at its lower end and at the top of the gorge mentioned, converting the valley into a pond connected at its upper end with the river. The dam is of unusual construction and is clearly shown by the accompanying section. The up-stream face was built of masonry, backed by concrete; the down-stream part a rock-fill, with a strong concrete envelope, and is probably the first structure of its kind built with an ogee face. It is very strong, has a large factor of safety, and cost less than one-half that of a concrete or masonry dam, with an efficiency fully as great. The crest of this dam is placed at an elevation 2 feet below that of the main dam, to increase the flood discharge, the entire dam acting as a weir. The water is empounded to the height of the main dam by means of movable flashboards to be lowered in time of floods.

Describing the canal in general, it has a total length of 10,000 feet, including the two reservoirs before mentioned, 8,000 feet of this being canal proper. It is largely excavated in rock, in the proportions of ⅓ rock to ⅔ earth. The standard dimensions for the rock section, earth section, and part rock and part earth section, are shown in the accompanying drawings. The rectangular section was shaped b (bottom width) equal to 2 d (depth), and d equal to b divided by 2. The trapezoidal section was computed on the following formula:



ction through Cut in Rock.

Section through Cut in Earth.

Cross-Section on Side Hill.

The Engineering Record.

SECTIONS OF CANAL.

$$d=\sqrt{\frac{a}{\frac{2}{\sin\theta}-\cot\theta}} \text{ and } b=\frac{2d}{\sin\theta}-2d\cot\theta$$

in which d equalled depth, b bottom width, a area and θ the angle the slope makes with the horizontal. The established area for the rock sections was 375 square feet, the earth section 450 square feet.

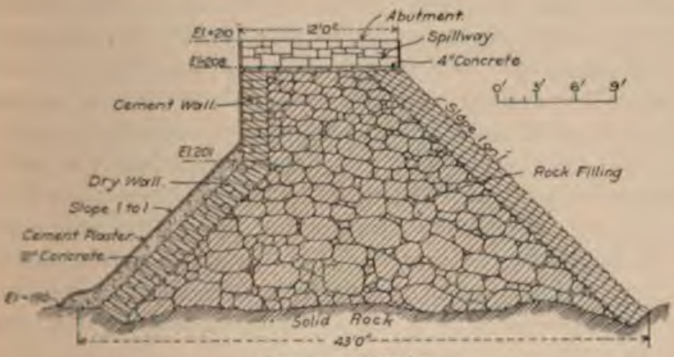
The sectional area of the canal was computed at an elevation 2 feet below the crest of the dam, allowing the pond to be pulled down 2 feet without reducing the area below the established figures. Allowance was also made for the loss in head due to the surface slope necessary to give the desired velocities.

The surface slopes were calculated with much care, each particular section being treated separately, Kutter's formula being used. The loss in head in general using a coefficient of roughness of .035 in the rock, and .025 in the earth, was .3 per 1,000 feet in the former and .2 per 1,000 feet in the latter, for the extreme conditions when a maximum of 1,200 second feet is being used. The flow for some three months through the upper part of the canal from the dam to the waste gates was observed daily and showed the calculated slopes to be conservative.

As before stated, the canal for a large part of its length was traced along the hillside, which called for a bank on the lower side, in some cases the cut and fill balancing. In general, the slope of the earth bank was made 1½ to 1. In some cases, however, where necessary, the inside slope was 2 to 1. In all cases where the waste rock from the cuts was within reasonable hauling distance, a heavy backing of loose rock was given the bank. On the curves and in some of the straight parts, the inside of the earth banks was paved with stone taken from the rock cuts. The joint between the earth and rocks under the banks was protected by a puddle trench under the toe, as shown on the map attached, the uneven surface of the rock making this feasible. Nearly a mile of the canal was thus protected. All puddle used was composed of 25 per cent. of clay and 75 per cent. of gravel, carefully mixed so as to fill the interstices of the gravel with the clay. This was put in in very thin layers, not exceeding an inch, slightly dampened with water and well packed by rolling and tamping. Frequent tests showed this to be perfectly water-tight. The earth banks themselves were made of the best material obtainable, and were built up in very thin horizontal layers, from 1 to 2 inches in thickness, and well packed by carts, wheelbarrows and horses. This method of construction showed excellent results. The sod was first removed under all banks and the original ground lightly plowed to give bond with the new material, and all roots, sods and vegetable matter carefully excluded from the fills. The top width of banks adopted is largely in excess of that generally used, being the height of the bank plus 2 feet; that recommended by Trautwine is 2 feet plus twice the square root of the height, and that by Turneaure and Russell ⅕ the height plus 5 feet. A 10-foot bank by the first authority would have a top width of a little over 8 feet, and by the latter a width of 7, as against 12 feet in the Bull's Bridge work.

All banks of a height of 13 feet and over were made with a uniform width of 15 feet, excepting the forebay banks, which were made 16 feet wide, with an average height of about 14 feet. These widths allow of any slumping which may occur at the top edges, from rain wash or other causes.

Several times mention has been made of the two artificially created reservoirs in the line of the canal. The first of these, about 1,800 feet below the dam, was formed in a valley by a dyke of earth with a loose rock backing, placed across the river end of the valley, and by a rock-fill dyke built across a depression at the beginning of the second section of the canal. This reservoir has a superficial area of about 8 acres.



Section of Dyke.

It has a considerable drainage area, sufficient to supply a brook of some size running the year round, in consequence of which the rock-fill dyke was converted into a spillway at its top, and another was added at a depression in the rim of the reservoir, giving a total length of spillway of 250 feet, the top of the spillway being at the same elevation as the crest of the dam. The rock-fill dyke, a section of which is given herewith, is of unusual construction in the East, though of common use in the western country. In the present case it had economical value as well, as it was formed from the waste rock in the canal cut near by, and built at a point where the earth material was scarce.

Concrete plastering and rubble masonry laid in cement mortar is depended upon for water-tightness.

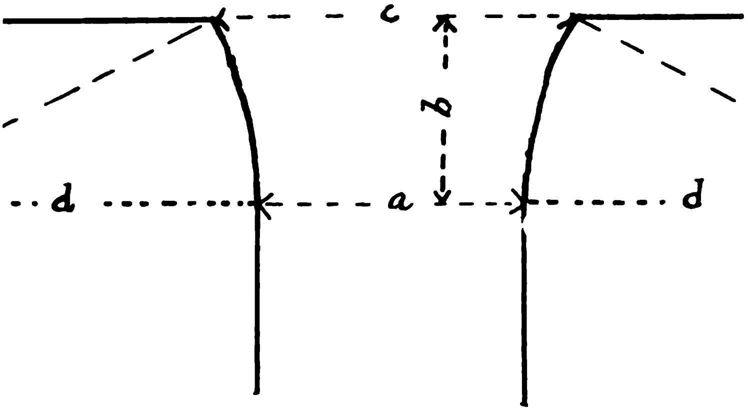
A similar reservoir of some [illegible] acres is created 4,000 feet below by an earth dyke with a heavy rock backing, practically dividing the canal into three sections: that from the dam to the first reservoir, from the first to the second reservoir, and from the second reservoir to the forebay. The first in round numbers [illegible] feet long, the second 4,000 feet long, and the third a little less than 5,000 feet. In addition is the forebay with an area of about [illegible] acre. These reservoirs, created without any additional expense, are of great value in the operation of the works, as can readily be seen. When a sudden demand is made for water on the wheels, accelerated velocity is necessary through comparatively short sections of the canal. Where the canal is one long stretch of two miles without breaks, an appreciable amount of time would be required to increase the flow of water, and a larger canal section would be advisable.

Some [illegible] steam drills were in constant use on the rock work, the maximum depth of the holes drilled being [illegible] feet. The holes generally were loaded with dynamite at the bottom, and blasting powder over the dynamite. The rock was very irregular and seamy, and the amount of explosives necessary was unusually large. All rock seams, after the excavation was completed, were carefully plastered up to prevent leakage.

The rock was hoisted from the cuts by guy derricks, and either wasted on the sides or loaded into dump cars for transportation to other points. The derricks were operated by double drum hoisting engines. Some 14 derricks in all were used. In shallow cuts teams and stone boats were worked to advantage.

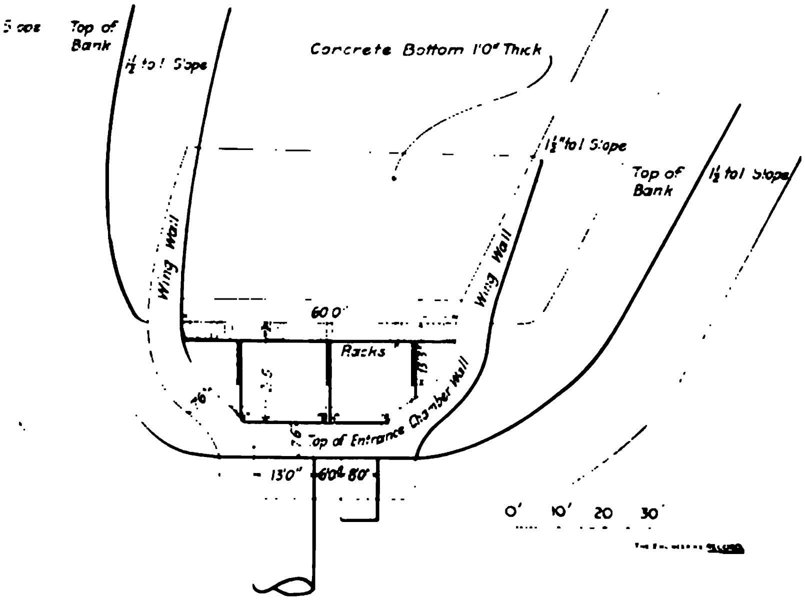
Earth was transported by wheelbarrows on short hauls, drag and wheel scrapers for longer distances, and wagons in extreme hauls. The bulk of the work was accomplished in six months, over one thousand men being employed.

All canal entrances or discharges were made with flaring openings, the size of the opening being computed by Trautwine's rule, the width of the opening being 1.4 that of the standard width of the canal, and .7 of this width distance in feet from the opening to the standard section. The sides were arcs of circles with a radius of [illegible] the canal width, thus:

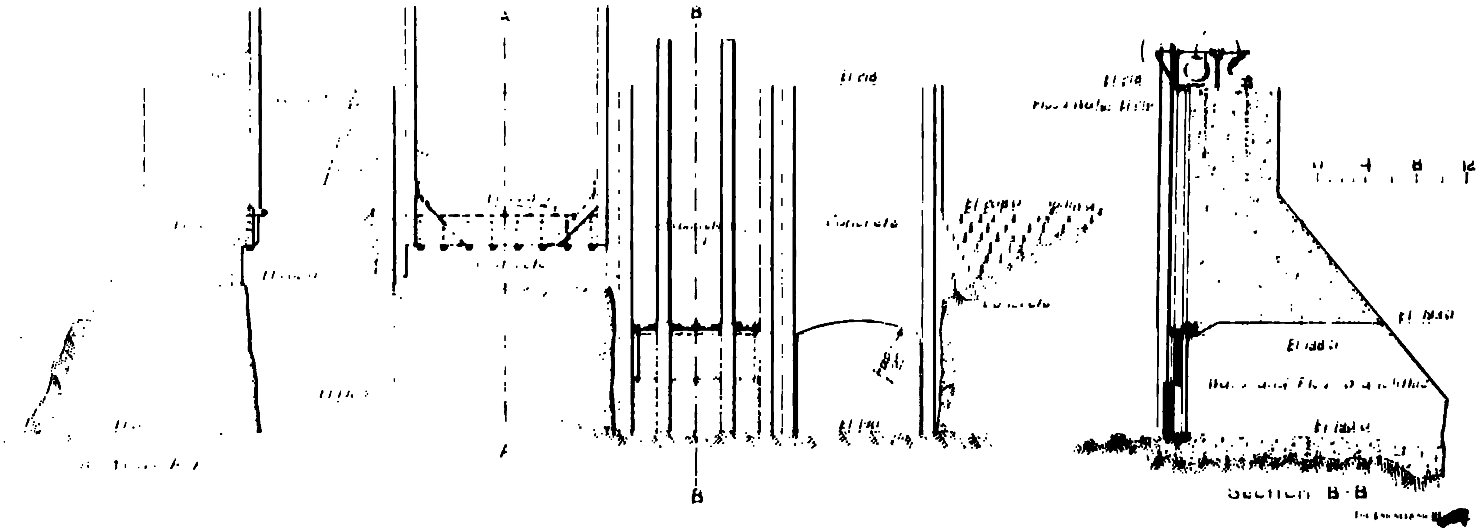


CANAL ENTRANCE ENLARGEMENT.

$$\left.\begin{aligned} b &= .7\,a \\ c &= 1.4\,a \\ d &= 1.333\,a \end{aligned}\right\}$$


Slope
Top of Bank
$1\frac{1}{2}$ to 1 Slope
Concrete Bottom 1'0" Thick
$1\frac{1}{2}$" to 1 Slope
Top of Bank
$1\frac{1}{2}$ to 1 Slope
Wing Wall
Wing Wall
60 0"
Racks
Top of Entrance Chamber Wall
13'0"
6'0"
8'0"
0'
10'
20
30'

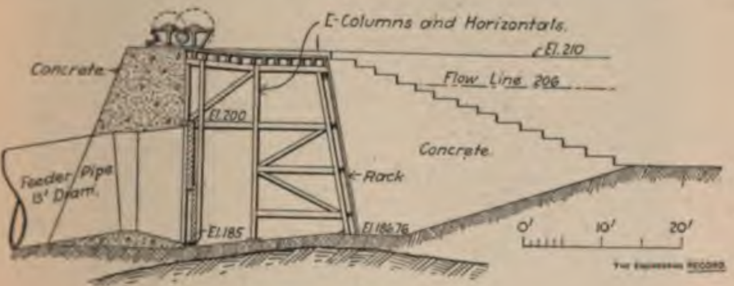
PLAN OF ENTRANCE CHAMBER



GATES AND RACKS

This practically prevented loss of head at these points. When changes in canal sections were made they were done on graduated lines.

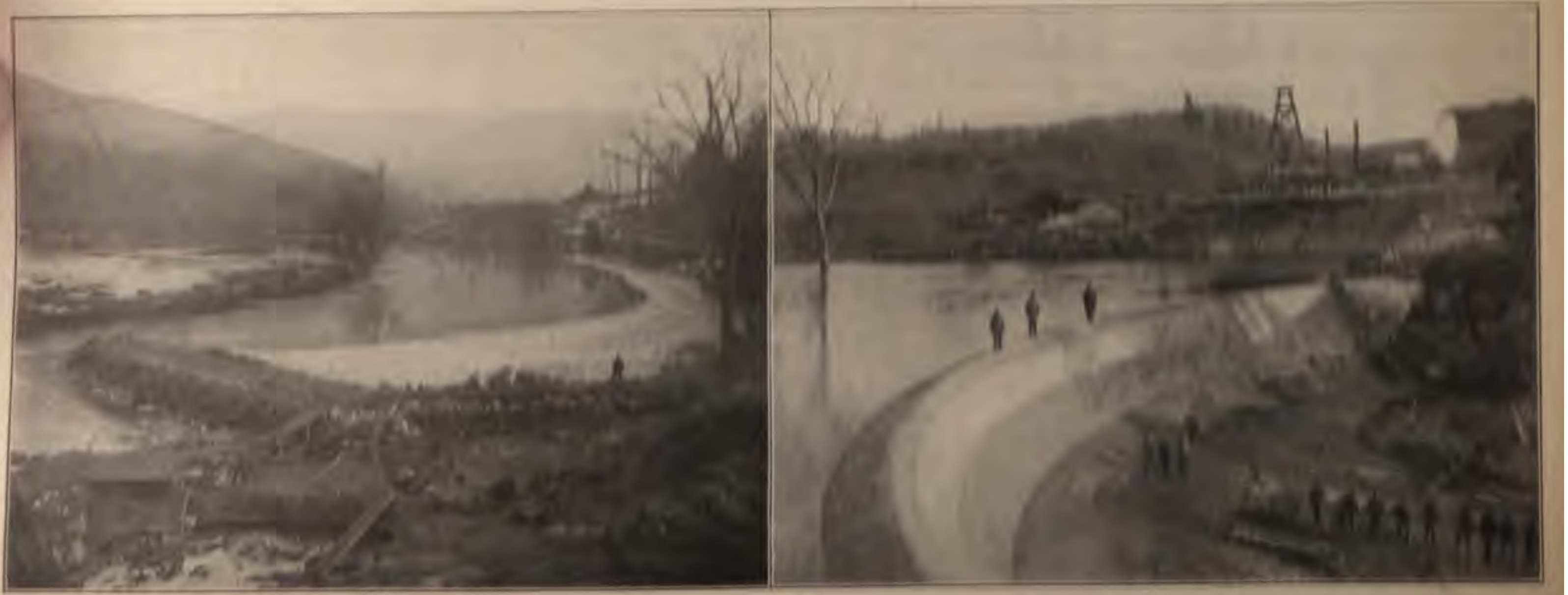
It is considered important to have as large a forebay or reservoir at the inlet of the penstock as consistent with the local conditions, and the one at Bull's Bridge is made something like an acre in extent. The north end is formed by rock ledge and is converted into a spillway overflow at the same elevation as the crest of the dam. The lower end constitutes the entrance chamber to hold the racks and the gates covering the entrance to the penstocks. The sides are formed of earth banks of unusual thickness; the canal enters at its northeast corner, gradually widening as it approaches the forebay, the turns being made on easy curves; in fact the least radius allowed on any turn to the canal was 250 feet.



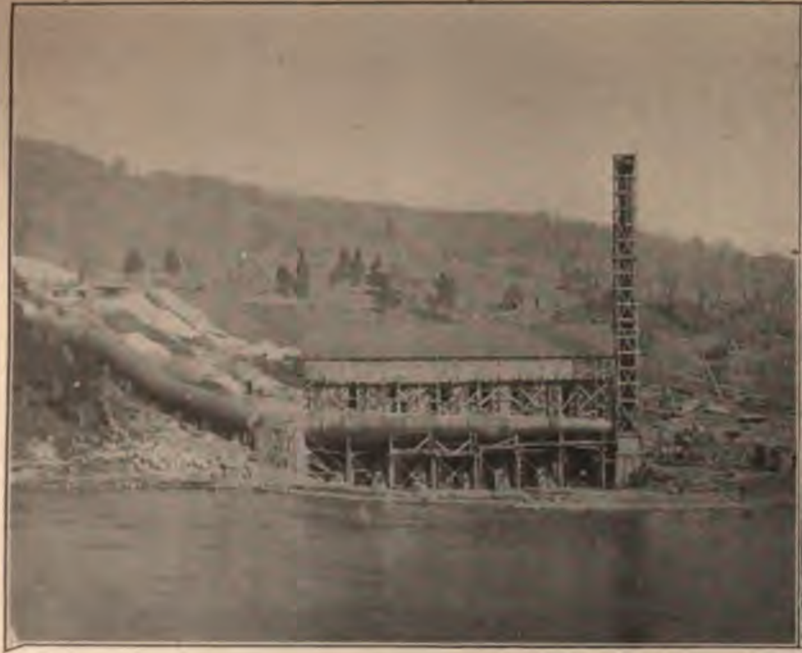
SECTION ENTRANCE CHAMBER.

The entrance chamber is formed of concrete walls resting on solid rock and is shown by the drawing. The racks have a width of 60 feet, and are placed 21½ feet from the pipe entrance, an unusually long distance. The contraction to the pipe entrance is made on gentle reverse curves, giving an easy flow to the water, also unusual, the ordinary shape given to an entrance chamber being an oblong box with square corners.

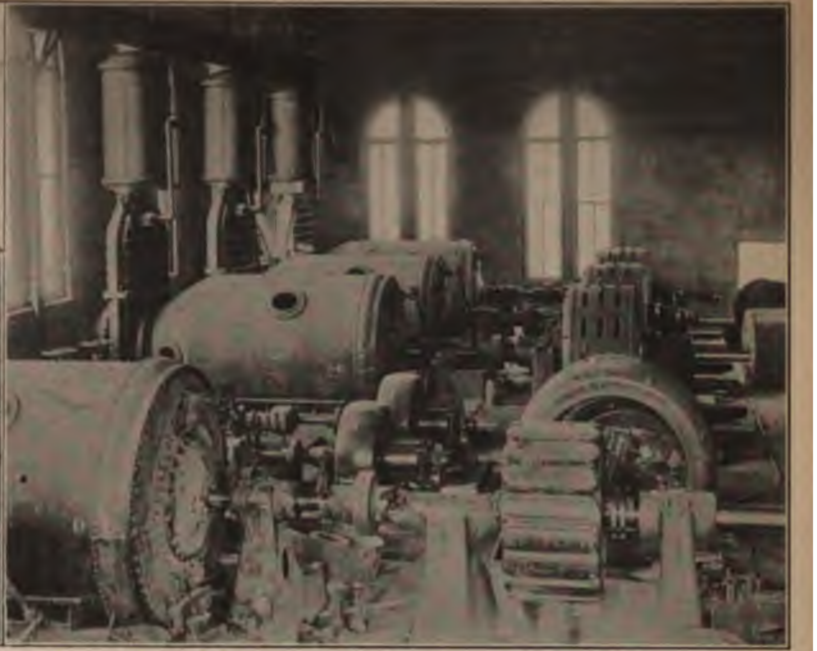
Two steel riveted pipes are let in the entrance chamber, both with bell-shaped mouths of 2 feet greater diameter than that of the pipes themselves. The smaller pipe, 8 feet in diameter, extends but a short distance below the forebay walls, and is intended for use when the plant is enlarged, as will be done at no very distant date. The main pipe, 13 feet in diameter,



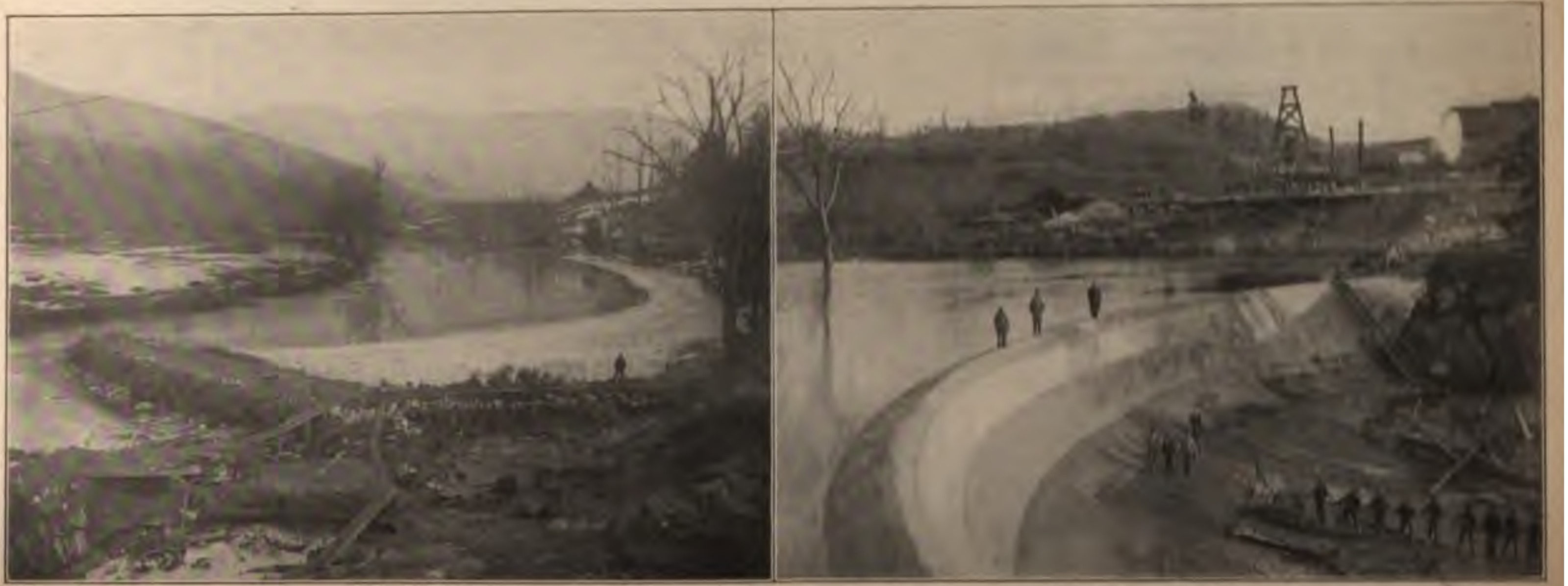
VIEW OF DAM.



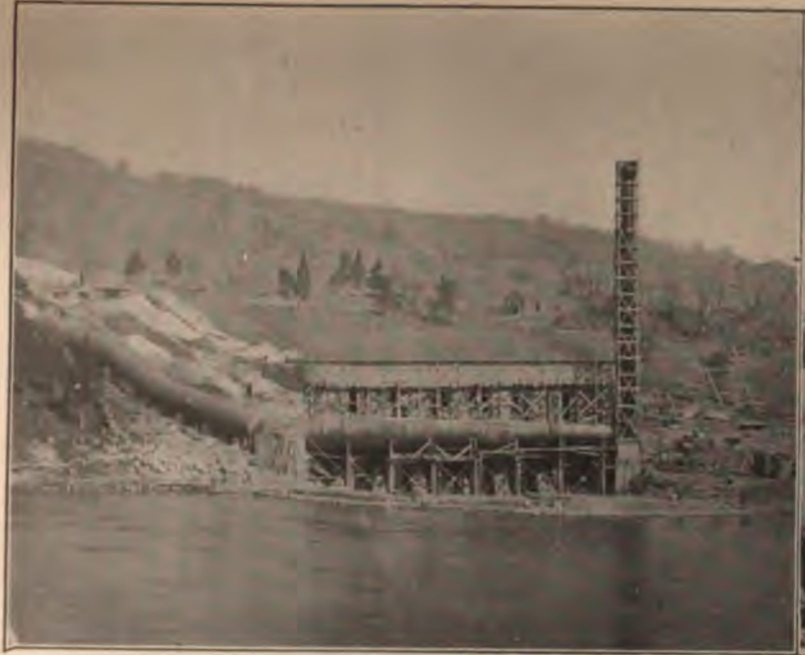
POWER HOUSE, SHOWING DRAFT TUBES.



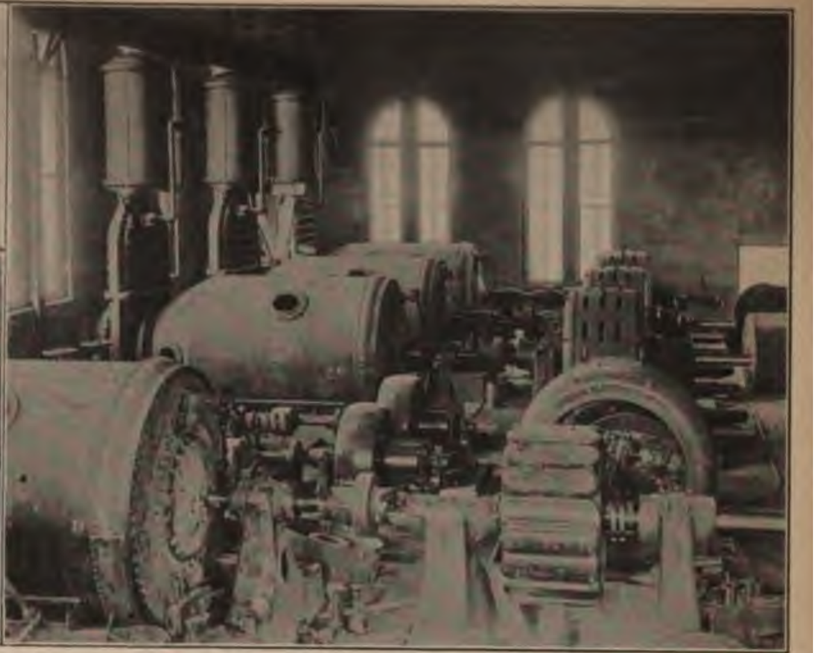
INTERIOR POWER HOUSE.



VIEW OF DAM.



POWER HOUSE, SHOWING DRAFT TUBES.



INTERIOR POWER HOUSE.

extends from the forebay down the hillside at an inclination of 13 degrees with the horizontal, to the northwest corner of the power house, thence with a horizontal turn of 50 degrees parallel with the power house along its river side, and terminates at the end in a stand pipe 5 feet in diameter, whose top is 1½ feet above the crest of the dam. This pipe is supported on concrete saddles down the hill, bottom on the rock ledge, and in front of the power house by steel saddles supported on steel columns, the latter also resting on rocks. The pipe shows most excellent construction, and was substantially water-tight from the time it was first filled.

Power House.

As before mentioned, the power house is constructed of concrete and steel. It has a total frontage parallel with the river of 115 feet; the width of the main building is 48 feet, and the annex, forming a part of the main building and placed at the rear and in the center, is 44 × 48.

The installation consists of six waterwheel units, two wheels in each, and each unit with a capacity of 1,750 horse power, making a total of 10,500 horse power. The wheels are of the improved Victor High Head Type, of great efficiency. They are directly connected with six General Electric Company generators of the alternating type, three-faze system, having a voltage of 1,150 amperes 503, with 400 rpm. They are connected by cable wiring with the latest type of high tension oil switches, automatically operated by electric motors, from thence are carried to the switchboard, which is placed on a raised platform above the ground floor, and contains the latest apparatus for manipulating and controlling the current. From the switchboard the current is conveyed to the transformers, which are placed in a separate room divided from the main part of the building by a fire-proof concrete wall. The transformers are of the oil type, cooled by a circulation of water and transform the current from 1,150 volts to 33,500. There are two banks of transformers, three in each bank; the current thence connected with two lightning arrestors, one for each line, and from thence is conveyed to Waterbury and points beyond over a double pole line, each line carrying three seven-strand aluminum wires.

The poles generally are placed 125 feet apart, and vary from 35 to 50 feet in height.

A travelling crane is erected in the main building with which the machinery is readily handled. This crane spans its entire width and rests on T rails supported on steel columns. The valves controlling the water entering the several water units through the intake pipes, which tap the main pipe outside the building, are operated by hydraulic cylinders. The wheels are governed by Lombard governors maintaining a uniform rate of speed of 400 rpm.

This completes a general description of the work, a detailed description of which would be impossible in this paper. Many of these details, however, are explained by the drawings which are hereto attached.

FORESTRY IN RELATION TO CITY WATER SUPPLIES.

By Prof. H. S. Graves, Director Forest School, Yale University.

It is now the policy of those in charge of city water supplies to acquire absolute control of the lands which drain into their reservoirs. Every important water concern already owns a large amount of land, and is extending its holdings as fast as available funds permit. The object in acquiring this land is to keep off undesirable inhabitants, and in every other possible way to insure the purity of the water draining into the reservoirs. The owners of these watersheds and the engineers in charge of the works are interested in forestry because of the supposed influence of a forest cover on the volume, on the regularity of discharge and on the purity of water draining from a specified area. As land owners, water concerns further are interested in forestry as a possible means of improving the conditions of their property, and effecting in the long run a larger financial return than is possible under ordinary treatment.

If, as is often claimed, forests increase the volume of water obtained from a specified watershed, if they regulate the flow of the streams which feed the reservoirs, and if they tend to purify the water which drains beneath them, owners of watersheds will eagerly spend money in establishing forests; and if good forests will accomplish all these results better than poor ones, these owners will invest money in work of improvement which will better the condition of their woodlands.

I regard the invitation to speak to-day as an inquiry from the members of this Society as to what, in my judgment, forestry means for hydraulic engineers and others interested in storing water for drinking purposes.

INFLUENCE OF FORESTS ON THE VOLUME OF DISCHARGE OF WATER.

Forests are said to influence the volume of water discharged from a specified catchment area, because the trees protect the soil from the direct action of the sun and winds, and consequently the evaporation is less than in the open. The amount of water evaporated from a forest soil plus that lost by evaporation from the trees and by the transpiration of the leaves, is said in general to be less than the amount evaporated from open land. Thus Mr. G. W. Rafter, who has written extensively on this subject, concludes that forests in the northeast on an average increase the run-off from 4 to 6 inches a year. He bases his conclusions on measurements of run-off in the upper Hudson and upper Genesee systems in New York. On the other hand, Mr. C. C. Vermeule, who has worked on the problem in New Jersey, concludes "that the effect of our New England and Middle States forests upon the total run-off of streams, hence upon evaporation, is not important enough to be shown in the measurements of stream flow."

Personally I can see no reason for doubting Mr. Rafter's measurements. His conclusions are probably correct if applied to large averages; that is, applied to average conditions over a large area such as an extensive river system. I do not believe that they can be applied to every small secondary basin. We can not say that a specified wooded watershed of a few hundred acres in southern New England will yield 5 inches more run-off than if cleared of woods. On the other hand, the total run-off from cleared land may in some cases be greater than from the cleared land. Imagine, for example, a cleared area covered with scant vegetation and with soil hardened by exposure. After storms the water would run off rapidly as surface drainage. It is possible that under such circumstances an average forest would lose more water by evaporation and transpiration than an open area. Many investigators forget that trees draw for their supply of water chiefly from the subsoil; that is, from the drainage supply. This draining action of trees may be so great as to keep the stratum of soil which supports the roots of the trees relatively dry. This is well seen in Europe, where frequently swamp lands are practically drained by planting spruce. After cutting such stands, the land immediately becomes swampy again.

It is probable that the permanent destruction of the forests in the mountains about the head-waters of our large rivers would be followed by diminution of stream flow, as claimed by Mr. Rafter. It is certainly followed by great disturbance of the regularity of stream flow. The present flow of our large rivers may be less than it was before the country was at all settled. I doubt, however, whether the average localized cutting now carried on in southern New England very much affects the total volume of water draining into a specified river system. The area of forest land is not decreasing appreciably, and in some sections it is increasing. Some sort of forest cover almost invariably follows a cutting, and it is only where the fire is permitted to burn year after year that a forest cover is prevented from reëstablishing itself. This is particularly true in southern New England, where the forests are chiefly composed of hardwoods which very readily reproduce themselves by sprouts after cutting. Personally I can not believe that the cutting of a hundred or two acres on an average southern New England watershed will be followed by an appreciable diminution in the volume of the water draining over that area; and if there were any diminution, it would be a temporary matter because of the quick reëstablishment of the forest cover.

Water concerns are urged to plant up their waste land in order to secure this supposed increase in volume of drainage water. If this were the only thing to be gained by the planting, I would advise against the expenditure, because under the average conditions prevailing in this region the increase would be too small to pay.

INFLUENCE OF FORESTS ON THE REGULARITY OF DISCHARGE OF WATER.

The influence of the forest on the regularity of water distribution through the year is a much more important question for the engineer of this region than that of total volume of discharge. There is no question in regard to the effect of the forest cover on the regularity of stream flow when applied to mountain conditions. Mountain forests retard the melting of snow in the spring, and tend, therefore, to lessen the severity of freshets. They offer, through the undergrowth and the forest floor, a physical hindrance to rapid surface drainage, and they preserve the soil in a porous condition most favorable for holding and slowly distributing the water by seepage. In southern New England the chief influence of forests as regulators of run-off results from their effect on the physical character of the soil. In a forèst conservatively handled, the soil is kept porous. This is partly due to the action of the humus particles in mixture with the upper soil, partly to the action of the surface layer of humus and litter which protects the soil from drying, and partly to the mechanical action of the roots. Under these conditions the water drains into the reservoirs more slowly after storms and after the melting of the snows in the spring, than if the soil is hardened on the surface. A greater volume of water becomes available for use for a water concern if it requires two weeks for the precipitation of a given storm to reach the reservoirs, than if it runs off in a day or two and a large amount of water is wasted over the spillways. But a forest will be of no value in this respect if the surface is constantly burned over. If a forest is fired every year, the surface of the ground becomes so hardened that water runs off as it would from the roof of a house, instead of finding an outlet through underground percolation. We have found in New Haven that ground which has been burned annually and has lost its cover of humus, becomes so hard that under some circumstances acorns are unable to germinate; that is, the little rootlet is unable to penetrate into the soil to get a foothold. Such a condition must necessarily result in more rapid surface run-off than if the forest floor had been protected. My personal belief is that the continuous burning of the surface of the watershed is more detrimental to the regularity of the water flow than the occasional clear cutting of parts of the forest.

Influence of Forests on the Purity of Water.

The third inquiry is whether forests have any influence on the purity of water. Numerous experiments prove that forest soils are purer than agricultural soils. The more exacting of the bacteria, among which are counted the pathogenic sorts, find less favorable conditions for development in forest than agricultural soils. The manures and fertilizers, particularly the nitrogenous matters, favor the increase of bacteria, and in forest land there is a minimum of this matter.

It is put in a nutshell by Professor Ebermeyer of Munich, who says in substance: The relatively low degree of moisture in the stratum of soil occupied by roots, the protection of the upper soil against rapid changes of temperature and moisture, the relatively low temperature of the soil, the paucity of nutrient required by the more exacting of the bacteria, the frequent occurrence of humic acid in the surface layers, are characteristics more favorable for the life and development of molds and saprophytic fungi than for bacteria. On the other hand, the higher temperature of the cultivated soil, due to the direct sunlight, the greater chemical activity, the porosity, and the tendency to quick changes in temperature and moisture, constitute favorable conditions for bacteria. The upper surface of the soil in the open is dried in summer and the dust blown about, thus spreading the bacteria through the air and conveying it to new places. Where bacteria occur in forest soil, they are not blown about even when the soil is dry. When it is wet they do not enter the air. Moreover, they tend to cling to the humus particles like flies. The air is, therefore, purer than in cultivated places and in towns. The soils are not only freer of bacteria, but there are fewer kinds, and almost never of the pathogenic varieties. It has further been shown that the soil increases in purity with depth.

This applies to cultivated lands where there is more or less manure and other fertilizing matter. I do not know of any experiments which show that drainage from forest land provides purer water than from grass land which is entirely unused. I do not believe that in our conditions there is any appreciable difference in the purity of the water draining from a forest and that from an abandoned pasture. It is obvious that open land from which the mineral soil is apt to be washed into the reservoir, ought to be planted with trees or covered with some other kind of vegetation to fix the soil. The silting of feeding canals and reservoirs from open fields and from roads is a common experience of water companies. This is particularly frequent when the soil is soft clay. There is less mud sediment in water draining from a forest than from any other class of land. The planting of open fields which are likely to be eroded by rains is a simple remedy, and would eventually save money for a company in preventing the deposit of sediment in the reservoir. It is a simple matter also to prevent the washing from roads by changing their direction, or by erecting obstructions like walls of stone or wood.

Dust blowing from roads running along the edge of reservoirs may pollute the water by carrying pathogenic bacteria resulting from animal excrement or from other sources. This dust adds also to the material which will eventually be deposited on the bottom of the reservoir. A screen of trees established btween highways and feeding reservoirs would serve as a check to the dust which ordinarily blows in large quantities into the water.

A great deal of trouble has been encountered by the New Haven Water Company, and of course by many other concerns, from the leaves which blow into the reservoirs from the trees; if left in large quantities, they discolor the water and give it a disagreeable taste when the warm weather comes on in the spring. This difficulty may be largely removed by cutting the trees for a certain distance back from the lake. Another plan is to plant around the reservoirs a forest of evergreen trees, or at least a forest in which evergreen trees form a large admixture. Even if a few leaves do fall into the water, and have to be removed from time to time, the advantage of a forest cover more than balances the inconvenience and cost occasioned by the leaves.

From the standpoint of water storage alone a water company in southern New England owning its own land will not need to adopt forestry beyond protecting the land from fire, because eventually a forest would establish itself over the whole area. The land can not be used for agriculture or grazing, and it will therefore be abandoned. Under average conditions, a tree cover will return in 10 to 15 years. It will be a very poor forest from the technical standpoint, but it will shade the ground and help to control the water.

ADVANTAGES OF FORESTRY FROM A BUSINESS STANDPOINT.

From what I have said it may seem that after all forestry is a luxury rather than a necessity for a water company. On the other hand, I consider it the only method of developing the property from a business standpoint.

The land has been purchased to protect the watershed, and can not be used for anything except raising trees. It should be treated, therefore, in such a way as to produce the greatest possible profit from the trees. If abused or neglected, the growth of valuable wood and timber will be very much less than if properly cared for. It is short-sighted in a business concern like a water company or even a municipal board to neglect property which might be made to increase in value and to eventually yield a considerable return. The treatment of abandoned fields may be taken as a case in point. I have said that if a pasture is abandoned, it will be covered with tree growth under ordinary circumstances in about 15 years. In 35 to 40 years from the time of abandonment, it will produce 12 to 15 cords of wood of small value. If the pasture were planted, it would in 35 to 40 years produce 35 to 40 cords of wood, of which a considerable part could be sold for purposes other than firewood. There would be, therefore, three times as much salable wood produced, and of a quality which probably would bring four or five times the returns as under the ordinary method of waiting for natural seeding. From experiments at New Haven, we have proved that piling can be raised in 40 to 50 years. This applies to black oak, red oak and chestnut, and possibly other species may be made to grow as rapidly as these species. We have sold such piling for 75 cents to $1.00 on the stump. The oaks usually sell for about 75 cents on the stump, and it is possible to secure $\frac{1}{8}$ to $\frac{1}{6}$ of a cord of fuel from the top of each tree. Under ordinary conditions of neglected forests, only from one to three trees fit for piles or poles can be found per acre on an average when the stand is 40 to 50 years old. Thus at the Maltby Lake tract belonging to the New Haven Water Company, of something over 300 acres, less than 300 piles and poles were cut, and most of the trees are from 40 to 60 years of age. If this forest had been treated carefully from the start, I have no doubt that at least 50 to 100 piles and poles per acre could have been cut. In fact, I see no reason why a plantation of red oak and chestnut should not produce in 40 to 50 years at least 100 to 150 trees to the acre large and straight enough for piling.

It is a conservative estimate to say that in 45 years a chestnut and oak plantation would net:

100 piles and poles at 80c.	$80.00
50 ties at 20c.	10.00
10 cords of wood at $1.00	10.00
	$100.00

The pasture land would yield an average not over 12 cords of salable wood, or $12.00. The expense in the case of the pasture would be confined to taxes and protection, let us say 25 cents per annum. The value of this amount at the end of 45 years would be at 3½ per cent. compound interest, $26.45. In other words, the annual expenses are not covered. The expense of the plantation over and above that incurred by its treatment as pasture would be:

	Value in 45 years at 3½ per cent.
Cost of planting, $6.00	$28.20
Cost of thinning, 15th year, at $3.00	8.40
Extra cost of expert work and protection, 30c. per year	31.74
	$68.34

In other words, the investment of planting pays 3½ per cent. and yields about $30 to cover taxes and interest on capital. In the case of water companies, no charge ought to be made for interest on capital because the land is held primarily for other purposes than a forest investment. There is, therefore, an actual profit occasioned by the planting of trees on the pastures.

It is obvious from this example that it is to the advantage, from a financial standpoint, for water companies and water boards to plant up their waste areas.

Most companies, however, own not only pasture and other open lands, but a large amount of woodlands which will yield a profit as in the case of the plantations. There is scarcely an acre of woodland in southern New England which would not be improved in character and growth by thinnings. In ordinary woodlands it is possible, by careful thinnings, to reduce the necessary period between the seed and maturity of stands at least 10 years and often more. Not only this, but the percentage of straight trees fit for ties and poles will be much greater than without such treatment. Where there is a market for ties and other products requiring straight trees, it will without doubt pay to make improvement thinnings in young growth, even at an expense of $3.00 per acre, which is the average cost of such a thinning. Improvement thinnings in later life of a stand would yield enough to cover the cost of marketing the trees, and often enough to pay for expert work in selecting trees for cutting.

On most woodlands in southern New England there is considerable mature and deteriorating timber which obviously ought to be cut. This may be cut in such a way that the succeeding growth will be a fully stocked stand of desirable species. It will be unnecessary to plant because the cuttings have been made skilfully and the new stand obtained at no expense except that occasioned by the marking of trees for cutting, and in some cases the extra expense of removing the stand in several cuttings instead of all at once.

THE VALUATION OF FORESTS.

From these suggestions it will be seen that forestry costs something either in the form of actual investments in improvement work, or in extra supervision for marking trees, for cutting, etc. It means an investment which later will be returned with interest. The return will come from the greater yield in valuable timber when mature and the property itself will have a higher value because of its increased productiveness.

The time is near at hand when young woodland will be valued on the basis of its possible yield. At the present time cut-over land sells for about the same price, whether it will yield 30 cords in 25 years or 10 cords. The land so stocked that it will yield 30 cords ought to bring more than the other class of land. Water concerns have a great deal of difficulty in placing a value on land when making purchases. As far as I know, no purchase has been made where the amount paid is supposed to represent the true value of the forest based on its productiveness. Ordinarily the price paid is established by custom, or the company pays a price far in excess of the real value of the property. As yet there is no intelligent basis of valuation in case of dispute, such as often arises in condemnation proceedings and frequently in ordinary purchases. I look forward to the time when land acquired for public purposes may be purchased at a price which represents its true value as a piece of productive capital. This is the method long in use in Europe. For example, the Bavarian Government in condemning forest land for a right of way for a railroad, pays for it a sum based on the capitalization of the possible future yield of the property.

An example will make this clear. Suppose I have some sprout land just cut over. I intend to cut this periodically for cordwood at intervals of 25 years. A study of the area shows that it will produce on an average eight-tenths of a cord per annum, or in 25 years, 20 cords. The land is so related to the market that I can obtain $1.00 per cord, or in 25 years, $20.00 per acre. It costs me in taxes and other expenses 25 cents per acre per annum. I demand a return of 3½ per cent. on my investment. The present value of the land is, per acre:

$$\begin{aligned} \text{Value: } & \frac{20.00}{1.035^{(25)} - 1} - \frac{.25}{.035} \\ &= 20.00 \times .73 - 7.15 \\ &= 14.60 - 7.15 = \$7.45 \end{aligned}$$

Suppose the land already has a growth of sprouts 15 years old. The value of this wood should then be added to the value of the soil. But the value of the wood should be computed not from its present salable value, but from its future value discounted to the present. In 10 years it will be worth $20.00. The present value is therefore:

$$\frac{20}{1.035^{(10)}} - \frac{.25\,(1.035^{(10)} - 1)}{1.035^{(10)} \times .035} = 14.20 - 2.08 = \$12.12$$

Let this be added to the soil value, then the correct value of the property per acre is:

$$12.12 + 7.45 = \$17.57$$

The same principle of reckoning may be applied to all classes of land which is devoted to growing trees.

It is entirely practical and fair, in case of a dispute, for the parties to agree on a rate of interest to be used in the calculation; to agree further on the influencing factors which must be considered, such as taxes, cost of protection, sale value of timber; then have an impartial judge determine the future product of the stand. Even if this method of reckoning could not be agreed upon by the parties in a purchase to settle the price of land, it would give to the purchaser a definite idea of the land's real value, and he would know whether or not he is paying an excessive price.

FORESTRY ON THE LANDS OF THE NEW HAVEN WATER COMPANY.

These facts show some of the more important lines of work of forestry for a water company. The work now carried on by the New Haven Water Company may be of interest as illustrating further how a forest may be improved by careful treatment. The New Haven Water Company has made a coöperative arrangement with the Yale Forest School, under which the land about the Maltby reservoirs are available to the School for work of experimentation, and the School in its turn takes charge of all forestry work on the tract. More extensive forestry naturally is carried on over certain of these areas than would be required on many watersheds, because some work is in the nature of an experiment. Moreover the financial results appear very favorable because there is no charge for expert supervision, and a good deal of the planting has been done by students for practice, thus reducing the expenses of labor.

Like many other watersheds, the land is in part wooded and in part open pasture. The woods are on an average from 40 to 60 years old, composed of sprouts of chestnut, oak, maple and hickory mixed with a large variety of other hardwoods common to this region. The woods have been repeatedly burned in the past, and now the trees are deteriorating rapidly, many individuals dying each year. In some places the soil has become hardened on the surface, a condition which is unfavorable for the storage of water, and in addition retards the natural reproduction of trees. Our aim in treating this forest is to cut it off by successive thinnings, gradually replacing it by a denser stand of trees of seedling rather than sprout origin, and of the most desirable varieties. It would of course be possible to cut it clear all at once and replant the area. But the Company does not wish to make such a clearing, and we shall effect the reproduction more satisfactorily by gradual cuttings than if we were obliged to plant. The stand has been opened up by cutting the suppressed and defective trees, and those which are crowding more valuable individuals. This first thinning takes out 20 to 30 per cent. of the stand. The best trees remain. The appearance is incidentally very much improved, about 100 to 150 of the thriftiest trees being left standing to the acre. The cutting is done by contract, and costs 10 to 15 cents more per cord than if the land were cut clear. This applies only to the cutting and to the piling, and does not include burning of the brush, marking or supervision. As soon as we secure a satisfactory reproduction on the ground, we shall make a further thinning to give the young plants more light. This will be in about 5 to 6 years. It will take about 10 to 15 years before the trees are all cut off. Where large openings have to be made on account of defective trees, young plants are set out to fill the gaps as soon as possible. About one lake we have underplanted with evergreens in order to replace the present hardwood stand with a mixed coniferous and hardwood forest. If a stand is thrifty and will live for a good many years, a light thinning is made purely for improvement. The open land is being planted up as fast as the School can undertake the work. So far 59 acres have been planted. The work of planting would have cost about $7.00 per acre if it had been necessary to employ the labor. Fifty-four acres have been thinned in the manner described above, yielding 291 poles and piles and about 375 cords of wood. The gross receipts from sales will, at the end of this year, be nearly $1,500. The net receipts can not satisfactorily be given because a part of the money has been expended in experimental work, and much of the inspection has cost nothing at all because done by officers of the School. At the end of the year the books will show a credit balance of between $400 and $500.

Most companies would not be so favorably situated in regard to expert work, or have so favorable a market as the New Haven Company. Companies often hesitate to take up forestry because they are not certain of the extent of the investment which will be required, and also because they do not know how to proceed in carrying out the work. No general statement of the initial cost can be made because of the different requirements of different tracts. For most companies, the following plan would be the simplest mode of procedure. Secure, through the aid of experts, a forest map which should show in color not only the location of the different parcels of land owned by the company, but also the age and character of the forest. A detailed report would accompany this map, including a full description of the character and condition of each lot, and also the treatment required to put it into the best possible condition of productiveness. For open lots this would include the sorts of trees to be planted. As a result of the information gathered in the preparation of this map and forest description, conclusions may be drawn as to the total cost of protecting the tract against fire, the cost of expert work necessary to plant the open lots and to carry on improvement and other cuttings, the probable receipts at the present time, and the financial results in the long run. A complete plan of work may be drawn up to serve as a guide for the company, and for the engineer in executive charge of the field operations. At first it is necessary to employ expert foresters to prepare the working plan and organize the work, but there is no reason why regular engineers or superintendents of works should not eventually carry on the entire work with a minimum amount of consultation from outside experts. This is the policy at Hartford. A working plan was made and one of the assistant engineers was trained to do the field work of forestry under general supervision of a consulting forester. It is expected that in a few years the services of the consulting forester may be entirely dispensed with, except when new and unusual problems present themselves. The introduction of forestry need not involve a large amount of money each year, for the work of planting may be done gradually. The Hartford plan calls for 10 to 15 years to complete the work on the present holdings of the city. Under conditions as favorable as at New Haven, the cost of supervision and expert advice could be easily paid for from the sales of necessary cuttings and eventually yield a satisfactory profit. The extra cost of the annual improvements, such as planting, would involve not over $500 to $1,000 per annum, an expenditure required only until the forest is put into good shape. After this time incidental improvement work could be met from the proceeds of annual cuttings.

A STORAGE RESERVOIR AT NEW LONDON.

By W. H. Richards, Civil Engineer.

The reservoir, described below, is intended to provide an addition to the supply to the city by diverting the water of a new watershed into Lake Konomoc, the main storage reservoir, and is one of the several that may eventually be constructed on branches of the same stream.

Barns reservoir is situated in the towns of Salem and Montville, three miles northwest of the northwest end of Lake Konomoc and about ten and one-half miles from the city.

Its selection as a site for a reservoir was determined upon to avoid the delays and expense that the condemnation of a somewhat more desirable site would entail.

As constructed, it has an almost uninhabited drainage of 2.7 square miles, an area of 46.5 acres, and a capacity of about 170 million gallons, it being so arranged that any surplus can be stored in the Konomoc reservoir at a lower level.

The site is in the valley of a large brook surrounded by heavily wooded hills, the immediate banks of the basin being gravel and sand interspersed with granite boulders. The sides of the basin are thoroughly grubbed of all soil and roots down to clean gravel, but the bottom of the basin for an area of 11½ acres being covered with from 4 to 6 feet of muck, is protected with sand to a depth of about 1 foot after removing all stumps and projecting roots. The water stands about 20 feet deep over this area and in no place comes in immediate contact with the muck or decayed vegetable matter. This method was adopted to save the large expense which would be entailed by the removal of the muck and in the belief that the muck had largely exhausted its capacity to pollute water when so far below the surface.

At the upper end of the basin a shallow arm is cut off from the main lake by a, so called, filter dam. Above this dam no effort was made to grub or cover the surface, only stumps and

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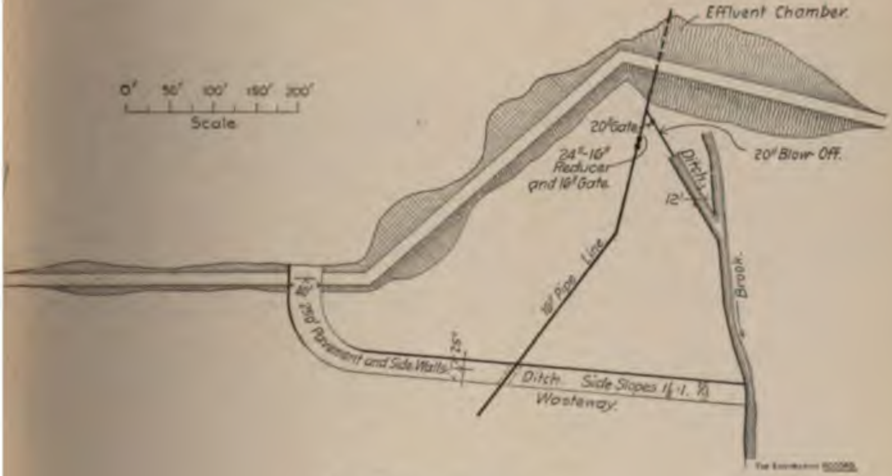
BARNS RESERVOIR.

roots being cut off close to the ground. The filter dam consists of a bank of coarse gravel about 400 feet long, 20 feet high, and 10 feet wide on top, and with slopes of 2 to 1 protected by loose rock. Through this dam is a 24-inch pipe and 24-inch gate and an overflow canal 18 feet in width passes around the north end.

The main dam consists of an earth and gravel embankment with concrete core wall about 1,200 feet long, the embankment varying in height from 10 to 25 feet above the natural surface.



GENERAL PLAN OF DAM.

A supplementary dam about 375 feet in length is located 200 feet east of the main dam. In locating the dam advantage was taken of a series of low hillocks, making the plan somewhat irregular but effecting a great saving in embankment. Gravel and sand of various degrees of firmness going to an unknown depth underlay the entire site of the dam. The necessity of building the dam at once prevented as complete an examination of the foundation as was desirable.

The test pits indicated that compact gravel containing boulders lay at a fairly uniform depth under the entire site of the dam, but on excavating the core wall trench a pocket of fine sand was encountered from 33 to 18 feet below the surface, running from a point 565 feet from the west end of the dam a distance of 375 feet, at which point it terminated very abruptly. This unexpected condition added greatly to the difficulties and cost of the work, as the sides of the trench above it had to be carefully sheeted and timbered to prevent the gravel on either side from running into the trench, and 4-inch grooved and splined sheet piling driven in the center of the trench, which was in some cases 40 feet in depth. This sheet piling is driven to hard bottom, a maximum distance of 22 feet below the bottom of the core wall trench, heavy wale pieces being bolted along the top and then the footing course of the core wall is built.

UP STREAM FACE OF DAM.

The driving of this sheeting at the bottom of so deep a trench was a rather delicate operation, and for a portion of the way it was driven with a steam rock drill, having a light hammer substituted for the drill and fastened to a frame which was lowered into the trench, but as the light construction of the drill caused it to break frequently an ordinary pile driver giving very light blows was finally substituted. The experience proved that with a sufficiently strong machine the rock drill has great advantages and economy over the ordinary pile driver for driving sheet piles in a trench.

The core wall is located close to the inner slope of the dam and the greatest care was taken to make it impervious. As no dependence was placed on it to resist strains or add weight to the dam, it was made but 3 feet thick up to within 18 feet of the top, where it begins to batter to 1½ feet thick at the top.

DOWN STREAM FACE OF DAM.

The concrete is formed of 1 part Portland cement and 9 parts of gravel and sand used as taken from the pit. This material from the pit, which was located in close proximity to the dam, was carefully examined at frequent intervals and the material kept as near the proportion of 3 sand, 2 fine gravel and 4 stone, not larger than 2½ inches, as possible. The concrete was mixed very wet, 1½ to 2 parts of water being used to 10 parts of stock, and was built in between forms, the inner surface being plastered with 1 to 1 mortar ½-inch thick and washed after the removal of the forms. It was found that mixing the concrete so wet vastly increased its density or lack of porosity, as when thrown between the forms the water arose to the top and ran off or evaporated. The concrete was built up in layers of about 2 to 3 feet, a triangular form being placed in the center of the top of each layer to form a groove to dovetail with the next layer. The cement used was Nazareth and Atlas Portland.

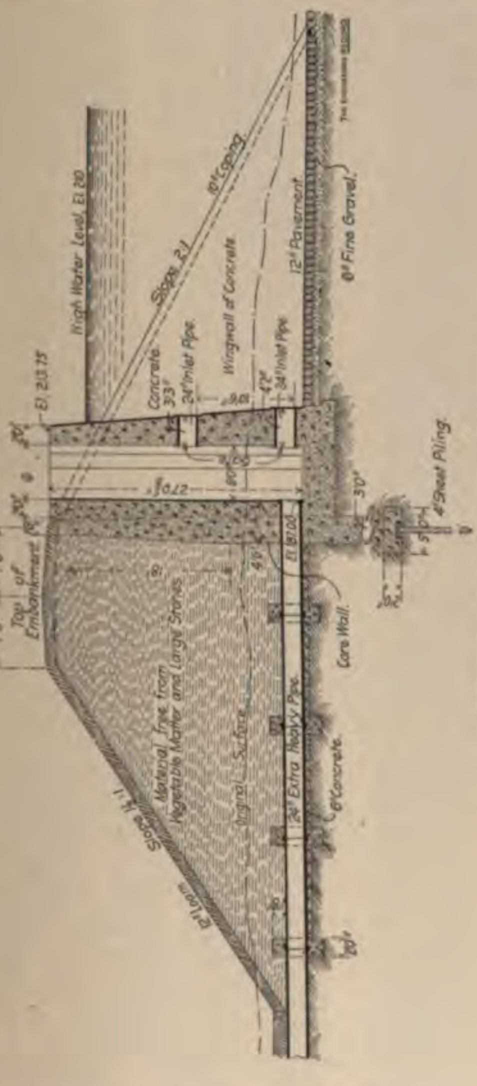
The embankment on the outside of the wall is composed of sand and gravel, the finer material being placed next the core wall and puddled, the coarse material outside this. This construction was adopted that the core wall might have as firm and uniform a backing as possible, and that in case of leakage the water might find its way through without destroying the embankment.

The embankment in front of the wall is composed of loam, thoroughly rolled, no clay being available. The inside slope is paved with 12-inch paving; the outside slope is finished with loam and seeded. The slopes are 2 to 1 inside and 1½ to 1 outside.

The spillway and wing walls are of granite. The spillway, which is near the east end of and lower part of the dam, is 40 feet wide or 15.8 feet for each square mile of watershed. The water falls over the spillway with a perpendicular drop of 3 feet and then runs down a paved slope of 12 in 100 into the brook below the dam. This location for the spillway was adopted to save the expensive construction which would be necessitated by its location on a higher portion of the dam.

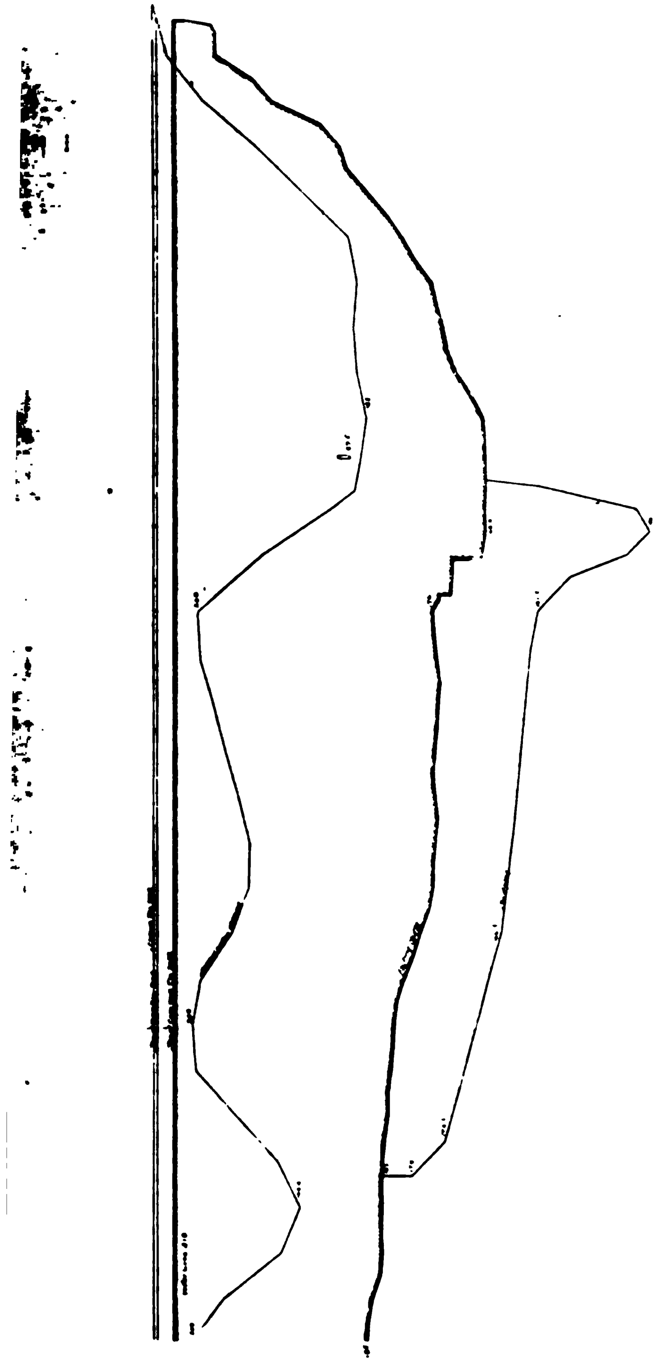
The effluent gate chamber is situated about 950 feet from the west end of the dam where the dam is 28 feet high. It is 7 feet by 4 feet in section and 27.8 feet deep below the floor of the gate house. The walls are of concrete similar to the core wall, excepting that large stones are placed in the concrete as built up. The walls average 2 feet thick at the top and batter 1 inch to the foot. Water is admitted to the chamber through two 24-inch sluice gates located 8 feet and 11.3 feet above the [illegible] [illegible] [illegible] [illegible] through two sets of screen frames as are set in the chamber. The discharge from the chamber is through a 24-inch heavy cast iron pipe, this pipe also serving as a blow-off through a branch to the old brook bed.

The level of the bottom of the effluent pipe is 187 feet and he crest of the spillway 210 feet above mean high tide. The



SECTION THROUGH EFFLUENT CHAMBER.

evel of Lake Konomoc, into which Barns reservoir discharges, s 178 feet above mean high tide or 9 feet below the bottom of he gate chamber.



PROFILE OF DAM.

A gate house [illegible] feet covers the effluent chamber. It is built of rubble stone and has a slate roof. A slab with appropriate inscription is inserted in the front face of the gate house.

After leaving the dam the size of pipe is reduced to 20-inch and continues this size for 1,700 feet, where it is increased to 24-inch and continues this size to the head of Lake [illegible]. This increase in size is made to provide for the discharge from another reservoir which may be built on a branch brook in the future.

The entire main is [illegible] miles long and is divided into two sections by gates and has the usual blow-off and air valves.

The contract for furnishing pipe was awarded to the [illegible] and the work of laying the pipe was awarded to The [illegible] Company of Boston, Mass. The contract for building the dam and reservoir was let in July [illegible] Jenkins & [illegible], but was abandoned by them in [illegible] and the work was finished by The [illegible] Company in a very satisfactory manner.

The cost of the work was greatly increased by the difficulties of transportation, as all the material used, including [illegible] had to be carried [illegible].

A temporary telephone line was constructed from Lake [illegible] to the work.

The whole work was executed under the direct supervision of [illegible] Assistant Engineer.

ROSWELL ATKINS.

In Memoriam.

Roswell Atkins was born in Bristol the 24th of September, 1826 and died there November 18, 1904, of heart failure.

He was the son of Lloyd Atkins and Charity Crampton. His ancestors came from Massachusetts and settled in East Hartford early in the seventeenth century, removing from there to Middletown in 1673, and subsequently to Southington. In 1799 his grandfather purchased a plot of land in the Stafford district, and in 1810 the house now occupied by Captain John H. Juliff was built by the elder Atkins. In this house the deceased was born. He attended the public schools and spent one term at the Suffield Institute, where he took a course in mathematics and surveying. When nineteen years of age he

(Prepared by William H. Cadwell and Algernon B. Alderson, members of the C. S. C. E.)

was apprenticed to George W. Bartholomew, who operated the first manufactory of table cutlery in the United States. The factory was at Edgewood. The venture was not successful and the business was sold to Pratt, Ropes & Co., of Meriden, the predecessors of the present Meriden Cutlery Co.

Mr. Atkins next entered the employ of the [illegible] C. Brown & Co. clock finishing firm at Forestville, remaining there until the spring of [illegible] when he engaged with Rev. [illegible] Atkins, the pioneer saw manufacturer in this section. His compensation was one dollar for a day of [illegible] hours.

Rev. Mr. Atkins, [illegible] Whiting and others formed a company for the making of saws in [illegible] and Mr. Atkins was [illegible] maker and was soon appointed [illegible] department. Leaving [illegible] & Co. of Southington, manufacturers of [illegible] and harness hardware, he returned [illegible] with the Atkins [illegible] assignment, and in [illegible] the business was bought by [illegible] Brothers, the [illegible] then [illegible] streets. It was [illegible]

[illegible] with the late [illegible] but the business [illegible] by the [illegible] company at [illegible] first issuing [illegible] were [illegible] a safe [illegible] success- [illegible]

[illegible] it was [illegible] he was [illegible] town clerk [illegible] District [illegible]

[illegible] many new [illegible] and [illegible] there was no man so well informed upon all matters of the past in the town as was he. This was a matter of reputation and he was frequently consulted. He would never give information that he could not prove, and in his research was thorough always, showing a peculiar and notable ability in getting to the bottom of affairs historical. Another interesting writing was his history of Franklin Lodge, F. and A. M., which was placed in the corner-stone of the Masonic Temple in 1891.

In October, 1847, Mr. Atkins married Martha Hart of Litchfield, of which union no children were born.

In September, 1853, he married Sarah A. Barnum of Bethany, Pa. Mrs. Atkins survives him, as do also a son and daughter, Lloyd R., a physician in New York, and Amelia A. Whitfield, M.D. of Los Angeles, Cal.

Mr. Atkins was a member of the First Baptist Church for over half a century and served as deacon and clerk. He was one of the original members of the Bristol Fire Department and the president of the Veteran Association of No. 1 Company. He has served in nearly every office in the department, including those of commissioner and chief engineer. He was the oldest past master of Franklin Lodge, and was the first to introduce the order of the Eastern Star in this vicinity. He was a member of the Connecticut Historical Society and the Connecticut Masonic Veterans Association.

Mr. Atkins was elected a member of the Connecticut Society of Civil Engineers January 12, 1897, and continued in active association with it up to the time of his death.

JAMES P. BOGART.

In Memoriam.

James P. Bogart, son of John and Henrietta Candee Bogart, was born at New Haven, Conn., February 28, 1852 and died December 24, 1903.

His early education was obtained in the public schools of New Haven, graduating from the Hillhouse High School in 1869. He then entered the Sheffield Scientific School of Yale University, taking the course in civil engineering, and graduating in the Class of 1872.

(Prepared by Chas. A. Ferry and A. William Sperry, members of the C. S. C. E.)

After graduation he was employed by Mr. H. G. Scofield of Bridgeport, Conn., in general engineering work for about three years. In 1875 he entered the service of the U. S. Coast and Geodetic Survey and was employed for three years under R. M. Bache, in charge of a plane table survey of the region in the vicinity of New Haven. Upon the completion of this work he returned to Bridgeport and again entered the employ of Mr. Scofield, where he remained for about three years, during which time a detailed survey and map of the entire city was made from which an official atlas of the city was printed.

In 1881 the Legislature of Connecticut appointed a commission to promote the new and rapidly increasing interests of the deep water oyster-growing industry. This commission appointed Mr. Bogart to be its engineer, a position which he filled for about eleven years. During this time he executed a very careful triangulation of the Connecticut shore of Long Island Sound from the Connecticut River to Greenwich, a length of about forty-five miles; established an extensive system of signals and ranges for locating the boundaries of the oyster beds in the Sound, and surveyed and mapped seventy thousand acres of oyster farms.

This was a work for which he was peculiarly well fitted, as his natural carefulness, together with the training he received in the service of the Coast Survey Department, made him exceedingly careful and painstaking in everything he did; characteristics needed in a work of this kind where so important and diverse interests were concerned as related to the establishment of the boundaries between these oyster farms.

During this period he also served as engineer to the commission which, acting with a similar commission from the State of Rhode Island, established and defined the boundary line, below high water mark, between these two states.

In 1892 he bought out the business of Mr. Frank Bruen, who for several years had conducted an engineering office in New Haven, and took into partnership Mr. A. William Sperry, who had previously been Mr. Bruen's assistant. This partnership continued until 1899, when Mr. Sperry withdrew and Mr. Bogart subsequently continued the office alone.

His familiarities with the boundaries of the oyster beds, the thoroughness with which he performed his work and his strict integrity made his services much in demand in case of disputes between owners of adjoining oyster beds, in settling the correct location of boundary lines.

His work lay principally along the line of surveying rather than engineering, and was always executed with exceeding care and precision.

As a man he was of a quiet and retiring disposition, finding his chief pleasure in his home and the society of his family.

Mr. H. G. Scofield, in whose employ Mr. Bogart spent so many years of his professional life, thus writes: "He was a painstaking, conscientious workman, no detail being too small to receive careful investigation.

Mr. Bogart, though naturally of a retiring disposition, was a courteous gentleman, a genial companion and a loyal friend; and while fully recognizing the rights of others, was thoroughly insistent on the maintenance of his own."

He was a member of the New Haven Chamber of Commerce.

In 1888 he married Miss Helen Day, daughter of Warren H. and Eliza H. Day of Bridgeport, who, with two daughters, aged respectively fourteen and six years, survive him.

Mr. Bogart became a Junior of the American Society Civil Engineers, January 4, 1882, and a member July 3, 1895.

He was elected a member of the Connecticut Society of Civil Engineers January 9, 1900, and continued a member until his death.

PROCEEDINGS

OF THE

TWENTIETH ANNUAL MEETING

OF THE

Connecticut Society of Civil Engineers

Hartford, Connecticut, February 9 and 10, 1904

FIRST DAY, FEBRUARY 9TH.

Meeting was called to order at 11 A. M., by President Ford, who said: Gentlemen, as I look over the audience this morning I am inclined to believe that if it were up to the president to welcome you here to-day to this twentieth annual meeting of the Society, I would take a liberal view of the situation, turn the keys of the city over to you, and tell you to come and go as you please, do anything you wish except take the State Capitol back to New Haven. However, I am not vested with such authority and in order that you may not suffer thereby I have invited one to come in here to-day who has the necessary authority and will bid you a hearty welcome. I introduce to you His Honor, Ignatius A. Sullivan, Mayor of the City of Hartford.

MAYOR SULLIVAN: It falls to the lot of mayors of every city to welcome various organizations, and it always brings to my mind a line, I believe from Shakespeare, that "man in his day plays many parts," and that part of the mayor's duties which are the most irksome and the hardest to perform is to get up before an audience of professional men, or men of the various professions of the different callings of life, and try to impress upon them that he knows all about their business or profession; and sometimes it is necessary that we burn the candle into the small hours of the morning trying to condense all that perhaps you have learned in many years and put it before you in a concise, compact form, and have you go away feeling that we, as mayors, are perhaps the only men in each city who could properly fill that office. And so to talk to you as engineers this morning and tell you something you ought to know is somewhat beyond me.

It seems to me that when a boy the first man I recognized as being a great man was an engineer, but he was a man who had charge of a locomotive; and the next great engineer was the chief of the fire department, but I could not possibly understand why they called him an engineer because the real engineer had charge of a locomotive and ran the engine while the fire chief simply shouted orders to the other men. Later I became acquainted with other engineers, the stationary engineer, then the civil engineer, and still later I became acquainted with the sanitary engineer, and I presume it is with those men I am perhaps most familiar.

It has always seemed to me in taking a subject in mind that I would like to find out from whence it sprung, so to speak, and it seems to me that perhaps the first engineers we had were the birds of the air and beast of the fields, for they were taught by nature to build, and I suppose you engineers have tried to teach us down to this day how we might best build up. It has always been marvellous to me why it is that men in your profession go to the far East and in almost unknown lands and countries find relics of engineering, engineering at which we citizens of to-day marvel and which even the highest in your profession can hardly duplicate; and perhaps it seemed to me that it was a time when the average man in your profession had so far advanced that it seemed a life of simplicity was better for the advancing ages. Whether that is so or not you are seeking to-day, as I understand it, to build up to that high order which was set centuries ago.

Here in the city of Hartford we believe we are a little more energetic and brighter and see things a little differently from other cities; and we think it is well that the Engineering Association should assemble here, for we believe we are looking a little farther ahead and see things a little better than do other cities; it also brings to us the necessity for communicating or intermingling with men of your profession. And I would ask of you that you look around the city of Hartford and point out to us defects in our city and how we might better protect our welfare and beautify our already beautiful city. For I hardly believe there are many communities in this country which are following lines laid down by the cities of Continental Europe closer than we; and it seems to me we should welcome organizations and individuals such as the Connecticut Society of Civil Engineers.

I feel you have very much to do and perhaps the most to do with the upbuilding of any city. To you we must go for any improvements; and that being so I wish you would look over our beautiful city, which we think certainly for the size is the finest in America, and where you see any thing lacking I know our city engineer, Mr. Ford, will appreciate it and the people of Hartford will feel grateful if you will point it out to us. We are willing to take the lesson, study it and profit thereby.

The city of Hartford is always glad to meet the stranger and when I am traveling a few miles from home I always feel with pleasure that the stranger who comes within our gates is well taken care of; and although we have perhaps the largest convention ever held in the city opening to-morrow, I feel reasonably sure you will be accorded a hearty welcome.

As the chief executive of the city I extend you a most cordial welcome and the freedom of the city, and we guarantee you protection wherever danger may threaten. I am very glad to meet you, not only for myself alone, but for the people of the city of Hartford.

President Ford: Gentlemen, the time is up for closing the ballot for the election of officers for 1904, and also for the amendment to the constitution. I therefore declare the ballot closed. I will appoint as tellers Messrs. Spencer of Hartford, Ryder of New Haven, and Palmer of Norwich.

C. H. Bunce: Mr. President, I rise to a point of order. I wish to say a word before you appoint tellers and count this ballot. I believe it is clearly against our written constitution that this ballot be recognized at this time. I know that the authority for presenting it in the way it has been presented has been given by the action of the Society at its last annual meeting. At that time, the Society will remember, a committee was appointed, consisting of Professor Tracy, Mr. Graves, and myself to suggest an amendment to the constitution in the line of election of officers. That committee was appointed at the morning session with a request that they report to the Society in the afternoon. The committee held a meeting early in the afternoon and at the meeting after the dinner reported a skeleton plan of a proposed amendment. But we stated to the meeting that it was a matter which in our judgment needed a great deal more consideration and study than the committee had been able to give in the short time allotted.

At the request of the committee they were continued with instructions to go on and formulate an amendment for submission to the Society. The constitution says that an amendment, or proposed amendment, should be submitted to a meeting of the Society for discussion and then it should be sent out in the form of a letter ballot to be voted on and accepted or rejected.

Now, I say the way in which this matter has come before the Society is evidently owing to the action of the Society a year ago. Mr. Kellogg moved that the committee report be accepted and the committee continued as they had asked. The motion was seconded and the Secretary moved an amendment to that motion to the effect that the committee be instructed to prepare ballots and submit the amendment to be voted on at the next meeting. Mr. Kellogg accepted that amendment and the motion as amended prevailed.

Now, I don't believe, gentlemen, we have any right to override the written constitution by any such vote and I consequently make a point of order that this ballot is not regularly before this meeting, but that the report of the committee should be brought before the meeting for discussion and then it should go before the Society.

Secretary Jackson: Mr. President, I suppose it is up to the Secretary to reply in this case, and before proceeding I should like to read Article 8, Section 1, as follows: "Proposed amendments to this Constitution must be presented in writing at a regular business meeting of the Society, and signed by at least three active members. Amendments so presented shall be read at the meeting and a copy filed with the Secretary at the same time. At the meeting when presented the proposed amendments may be discussed and amended, but cannot be adopted."

Contrary to Mr. Bunce, I take the ground that the sum and substance of this amendment as sent out was drawn up, signed by three active members of the Society, Messrs. Tracy, Bunce and Graves, a copy was filed with the Secretary at the last annual meeting, it was read and discussed and legally brought before the meeting at that time, and I see no reason why we are not in order now to vote upon it. I think the constitution clearly covers that and I think the requirements of the constitution have been complied with.

PRESIDENT FORD: I would suggest that in order to bring the matter before the meeting a motion be made in some way or another and discussed. I would ask Mr. Bunce to bring it before the meeting.

MR. BUNCE: I move, sir, that the letter ballot called for and submitted to this meeting be not counted.

PRESIDENT FORD: Is the motion seconded?

MEMBER: I second the motion.

MR. BUNCE: Understand, gentlemen, I don't suppose it makes a great deal of difference one way or the other what course we take with this letter ballot, but it seemed to me that some members of the Society might think they had not had the proper opportunity to discuss the acceptance of the amendment as it was finally put in shape, and it was to offer such opportunity for discussion that I have brought the matter up. If any member wants to discuss it let him do it now and not wait as did a gentleman who was at one time a member of the Common Council and when a gentleman wanted to discuss some question he said: "There is no discussion until after the motion is passed."

PRESIDENT FORD: The matter is before you, gentlemen. Are you ready to discuss it?

MEMBER: Question.

President Ford then put the question and the motion was lost.

PRESIDENT FORD: The next business, according to our by-laws, is the presentation of and action upon the minutes of our last meeting.

SECRETARY [illegible]: The minutes have been printed in the annual report, and I don't think it is necessary to read them.

MR. BUNCE: I move they be accepted as printed in the annual report.

Motion passed.

PRESIDENT FORD: The next business is the report of the Board of Direction.

The report as follows was read by the Secretary and accepted.

REPORT OF THE BOARD OF DIRECTION.

A meeting of the Board of Direction was held at New Haven, April [illegible], when, in relation to communication from officials of the St. Louis Exposition, it was voted that the Secretary ascertain the latest date for receiving exhibits.

The matter of [illegible] reports of committees and substituting therefor [illegible] was left to the President with [illegible]

An invitation to the Society from W. Cadwell to visit the sewage disposal works at New Britain was tabled for future consideration.

The matter of arrearages in dues of several members was considered.

The resignations of the following members were accepted: J. H. Edwards, F. P. Lewis, E. C. Terry, F. T. Ley, C. H. Clark and F. P. Johnson. Five names were stricken from the roll of membership for arrearages in dues. Those present were: President Ford, Vice President Punderford, and Messrs. Kellogg and Graves.

At a meeting of the Board of Direction at New Haven, December 23, 1903, it was voted that the matter of sending exhibits to the St. Louis Exposition be indefinitely postponed.

The matter of arrearages in dues of several members was considered and one name was dropped from the roll. It was voted,

That the annual meeting be held at Hartford, February 9 and 10; that the Secretary send invitations to different engineering societies inviting them to send a representative to the twentieth annual meeting; that communication from Committee of American Society in relation to St. Louis Exposition be read at the meeting. The President appointed the following committee to take charge of the annual meeting: Messrs. Graves, Snell, Cadwell, Bush, Henderson and Clark. Voted, that this committee be empowered to draw on the Treasurer for sufficient money to complete arrangements for twentieth annual meeting.

Those present were: President Ford, Vice President Punderford, Messrs. Graves and Kellogg.

At a meeting of the Board of Direction at Hartford, February 9, the following names for active membership were approved: Arthur W. Bacon, New Britain; Vincent B. Clarke, Milford; Clinton L. Cole, West Hartford; Charles S. Farnham, Hartford; Albert H. Greenwood, Hartford; John Harte, Hartford; Samuel W. Hoyt, Jr., South Norwalk; Edward R. Ingraham, Hartford; Minor S. Jameson, Fairfield; John C. Jessup, Jr., South Norwalk; Edward J. Jones, Hartford; Arthur P. Law, Bridgeport; Flavel S. Luther, Jr., Hartford; George H. McLean, Bristol; Edward E. Minor, New Haven; Harold T. Murphy, Springfield, Mass.; Clarence H. Nichols, Danielson; William K. Pike, Danielson; William B. Pierce, Stamford; Seymour W. Robinson, Hartford; Philip Sellers, Meriden; William T. Taylor, Hartford; Myron H. West, Hartford; Howard E. White, New Haven;—and Gustave X. Amrhyn, New Haven; William H. Arthur, Stamford; Don O'Connor, Hartford, and Hartley W. Sperry, Old Saybrook, for associate membership. Three names were stricken from the roll of membership.

The accounts of the Treasurer were audited and approved. Those present were: President Ford, Vice President Punderford, Messrs. Kellogg and Graves.

MR. KELLOGG: I have been wanting a chance to say something. I would like to move that the names of those that have been dropped be left out in the publishing of the report.

PRESIDENT FORD: Your motion is to leave out the names of any members that have been dropped from the rolls.

Motion passed.

PRESIDENT FORD. The next business is the report of the Secretary.

REPORT OF THE SECRETARY FOR YEAR ENDING FEBRUARY 9, 1904.

To the Officers and Members of the Connecticut Society of Civil Engineers:

Your Secretary respectfully submits the following report for the past year.

In May twelve hundred copies of the Nineteenth Annual Report were printed and distributed to the members, to those societies with whom we exchange and to different libraries and institutions of learning. In accordance with vote taken by the Society, as complete a file of the Society's reports as the Secretary was able to obtain was deposited with the State Librarian. Upon inquiry, the American Society having been found to have a file, that matter was not pursued further. The Secretary having an opportunity to purchase some of the missing reports from the Illinois Society of Engineers and Surveyors, took the liberty to do so. The Secretary during the year has attended the different meetings of the Board of Direction, has had printed and distributed the two bulletins of the Society, the ballots for amendments to the Constitution, and for officers, and the notices for the twentieth annual meeting.

During the year twenty-eight new members have been elected, twenty-four active, three associate and one honorary. Two active members have died: Mr. James P. Bogart of New Haven, December 21, 1903; Roswell Atkins of Bristol, November 18, 1903.

SUMMARY FOR THE YEAR.

	Feb. 9, 1903.	Feb. 9, 1904.	ADDITIONS.		LOSSES.			
			Transfers.	Elected.	Deaths.	Resigned.	Transfers.	Dropped.
Honorary	3	4	...	1	....	....	..	
Active	206	207	..	24	2	9	.	[illegible]
Associate	2	5	...	3	....	.	.	..
Totals....	210	221	...	28	2	9	.	[illegible]

Report of Secretary then accepted.

President Ford: The next business is the report of the Treasurer.

Report of Treasurer.

J. Frederick Jackson, Treasurer, in account with the Connecticut Society of Civil Engineers for year ending February 9, 1903.

Receipts.

Cash on hand	$466.26
Received from advertisements	682.32
Received from back dues	78.00
Received from dues, 1903	291.00
Received from dues, 1904	120.00
Received from sale of reports	20.86
Received from sale of dinner tickets	69.00
A. Leschen & Sons, cost of cut for advertisement	2.25
	$1,729.69

Disbursements.

Annual reports	$772.89
Cartage	3.25
Dinners	75.00
Expressage	2.70
Freight	8.42
Postage	13.55
Printing, stationery and supplies	92.53
Rent of P. O. box	4.00
Rent of rooms for meetings	6.25
Stenographer's services	32.55
Traveling expenses, Secretary	1.55
Salary, Secretary and Treasurer	50.00
Telephoning	.40
Engraving of August bulletin	11.71
Engraving of December bulletin	9.40
Stereopticon	12.00
Expenses of Alfred E. Burton	8.00
Back numbers of reports	.90
Change supplied by Treasurer	1.25
Cash on hand February 8, 1904	623.34
	$1,729.69

Report of Treasurer then accepted.

President Ford: The next business is the report of any special committees. I would like to ask if there are any special committees to report at this meeting. I believe there are none.

Mr. Kellogg: I would like to offer the following resolution:

Resolved, That $100 be and the same hereby is appropriated to the Secretary and Treasurer of our Society for his services for the year ending February 9, 1905.

Mr. Manning: I would like to inquire if this is not an increase of $50 over last year?

President Ford: It is.

Resolution was then adopted.

President Ford: The next business on the list is the election of any new members. What disposition will you take regarding the new members?

Secretary Jackson: I have the following applications for membership, Mr. President, whose names have been received, published upon the notices for the meeting, approved by the Board of Direction and are now presented to the Society for acceptance.

Arthur W. Bacon, New Britain; Vincent B. Clark, Milford; Clinton L. Cole, West Hartford; Charles S. Farnam, Hartford; Albert H. Greenwood, Hartford; John Harte, Hartford; Samuel W. Hoyt, Jr., South Norwalk; Edward R. Ingraham, Hartford; Minor S. Jameson, Fairfield; John C. Jessup, Jr., South Norwalk; Edward J. Jones, Hartford; Arthur P. Law, Bridgeport; Flavel S. Luther, Jr., Hartford; George H. McLean, Bristol; Edward E. Minor, New Haven; Harold T. Murphy, Springfield, Mass.; Clarence H. Nichols, Danielson; William K. Pike, Danielson; William B. Pierce, Stamford; Seymour W. Robinson, Hartford; Philip Sellers, Meriden; William T. Taylor, Hartford; Myron H. West, Hartford; Howard E. White, New Haven;—and Gustave X. Amrhyn, New Haven; William H. Arthur, Stamford; Don O'Connor, Hartford, and Hartley W. Sperry, Old Saybrook, for associate membership.

Mr. Snell: I move that the list of members, active and associate, as read by the Secretary and printed on the list which we have, be accepted, and that the Secretary be authorized to cast one ballot for the Society for the election of all those names read.

Motion carried.

President Ford: The next business is the election of officers and as the tellers have not reported I will take this opportunity to read my annual address if there is no objection.

ANNUAL ADDRESS OF THE PRESIDENT.

Hartford, Conn., February 9, 1904.

To the Members of the Connecticut Society of Civil Engineers:

Gentlemen:—You are assembled here to-day at the twentieth annual convention of our Society, before your Chief Engineer, as I interpret the situation, anxiously awaiting the approval of your final certificates on the various contracts entrusted to you during the past year.

I anticipate that many of you are carrying heavy bonds for the faithful performance of your obligations and realize the pecuniary embarrassment you will be subject to by the assessment of an additional premium, if it becomes necessary for your Chief to further withhold the final payment.

At the beginning of our Society's year, it was generally understood that there was a large amount of engineering work to be performed in the State of Connecticut during the year 1903. As soon as the advertisement was published, inviting proposals for this work, your Chief Engineer, acting under the authority conferred upon him at the last annual meeting, submitted a proposition in behalf of our Society for the execution of this work. It was specifically stated at the letting that the list of qualities to be used as a comparison of bids was not guaranteed, and should be considered but an approximate estimate of the amount of work to be performed. The competition among the various bidders was of the keenest character, but the Connecticut Society of Civil Engineers, by the exercise of its usual good judgment, was successful, and found to be the lowest responsible bidder, and after qualifying as to bonds, etc., this contract was signed in behalf of our Society by your Chief Engineer. After looking over the situation, I was satisfied that it would require the united efforts of at least ten honorary and one hundred and ninety-eight active members to satisfactorily execute the contract, within the specified time. On account of the magnitude of the general contract and the diversified character of the work, it was considered advisable also at the start to subdivide the work and sub-let it under two hundred and eight individual contracts.

At the beginning of the year 1903, therefore, each one of you, as a party of the second part, entered into a contract with the citizens of Connecticut as parties of the first part, for the performance of a definite amount of work. Specifications were prepared for each contract, and it was distinctly understood that, if any differences arose over the interpretation of these specifications, your Chief Engineer was to be the final judge and his decisions could not be appealed from. It was also generally understood that while all of the contracts were to terminate on December 31, 1903, the maintenance period was to be extended to February 9, 1904, and a sufficient percentage retained until that time to protect the public, parties of the first part, from any injuries or damages, which might arise from defective workmanship or the unfaithful performance of your contracts.

It is unfortunate in one respect that all of you have come up here to the office of the Chief Engineer, on the same day for the same purpose, and under these conditions it will be impossible for me to render a decision at once which will satisfy all of the parties involved. I must be given sufficient time to review the various contracts in detail, as they are presented, and decide each one upon its merits. However, as you are assembled here in a body, I request that you remain as such for about thirty minutes, in order that you may profit by the criticisms or comments made upon the different contracts.

At the beginning of the year, I staked out as definitely as possible the general alignment you were to follow in carrying out your individual contracts. I fully appreciated the fact that this tangent marked a turning point in the history of our Society, but I was as fully convinced that if too much frictional resistance was not encountered, our Society as a whole would not be permanently sidetracked by one year's experience. The proposed grade recommended by your Chief Engineer was published and a copy mailed to each one of you in the form of a modest communication, briefly stating the reasons for the establishment of a new grade. This grade specified that "Bulletins" were to be issued periodically, and as no remonstrances were received at the Chief Engineer's office within the time prescribed by law, the assessment was levied. No appeals from the award of damages or assessment of benefits were filed and the new layout was therefore considered established.

It was expected by your Chief Engineer, at least, that each one of you was to stake out a small section of this new grade during the year, thus contributing your share to the information published in the *Bulletins* and that as soon as each contract was completed, a final voucher was to be forwarded to your Chief, defining the character and magnitude of the work executed, unit prices for the different classes of work, the difficulties encountered, the strong and weak features of your specifications, and especially a specific account of all extras allowed. These vouchers were to be exchanged with your fellow members by the publication of these *Bulletins,* previous to the termination of the maintenance period of your contracts, in order that we could all profit by a free discussion of the various complications encountered in carrying out the different contracts, and thus be better prepared to enter the 1904 contest unhampered by many of the difficulties encountered in the 1903 competition. As you are all aware, only eleven of these vouchers were filed in my office within the time prescribed, and I hope you have all examined these very carefully before appearing here for my approval of your final certificates. There are nearly two hundred who failed to make even a report of progress during the year and I, therefore, assume that obstructions were encountered in carrying out these unfinished contracts which were not shown by the soundings taken in the preliminary investigations and they must, therefore, be continued over into the year 1904.

I assume that a large share of your individual contracts can be grouped into classes, and a short review of the different groups seems essential to your Chief Engineer at this time to discover, if possible, the reasons why so many of your contracts remain unfinished.

BRIDGES.

I have some sympathy for those engaged in bridge and structural iron work during the past year. You have probably had as much, if not "Moore" trouble to contend with in carrying out your contracts than any other class of engineers in our Society.

The general "Bush" whacking which has been carried on with the U. S. Steel "Common" and "Preferred," has surely been sufficient to lay many of our bridge engineers in their premature "Graves." Some of you have spent hours and days,—yes, weeks, in theorizing and calculating on the "maximum flange strains" and "shears" for your different structures in order to save your clients a few dollars. You have provided for 100 pounds of humanity per square foot, for 10-ton road rollers, and for 30-ton electric cars, at 30 miles per hour, for your highway bridges and you have made ample provision for twentieth century traffic in your railroad bridges. You have escaped the "Bridge Pool," (a new term to Engineers) and awarded your contract to the lowest responsible bidder at a remarkably low figure. You have gone out to erect these bridges and as you were driving home the last rivet, you have seen one of "Mellen's five-hour limited's" with "one thousand souls" aboard, tearing down upon your completed structures, at a 60-mile clip, and you have lived a lifetime in the next few minutes It was up to you, and you, for once in your experience, wished you had followed good "Sage" advice at the start, thrown your calculations in the waste basket, "Chased" down to "New Britain Junction," and ordered one of "Bradley's Berlin Bridges." You all know that his company is the only one which has bridges built by the mile and all that is necessary to accommodate your particular conditions is to slide their continuous bridge under their big "Shears" and slice off just what you want. It may be a little too heavy or cut a little longer than necessary, but you can easily build your abutments strong enough or thick enough to carry it, and it's better to be safe than sorry. By following this course you are not "Robinson" of their profits, you are relieving yourself of a lot of nervous "tension" and "riveting" all "stiffness" on to Bradley, who then assumes all the "Dead" and "Live Loads."

GENERAL ENGINEERING PRACTICE.

I am sure that those of you engaged in a general engineering practice (a most "Noble" calling) during the past year, have put in a lot of extra "Knight" work, and have had many tall "Hills" to climb in your experience. You have "Gallup"-ed around our State and "Vorce"-ed your way to the front in the keen competition which has followed the letting of each contract in a manner which has clearly indicated that there has been no chance for "Moss" to grow under your feet. You have been enabled to "Ward" off non-resident engineers and thus confine the general engineering practice to our own membership.

You have had to design "Stone" structures and stake out "Storrs" "Patton"-ed after greater similar designs.

You have been employed by "Millers" and "Miners," although not professing to be mining engineers, and you have often "Nash"-ed your teeth in endeavoring to satisfy the whims of your different patrons. But, nevertheless, I am satisfied that every one of you "Hathaway" of proving your "Stirling" value to your constituents from the success which has crowned your best efforts.

HIGHWAY ENGINEERING.

To those of you engaged in constructing some of MacDonald's monumental highways during the past year, I can perhaps appreciate the reason why your contracts remain unfinished. After spending a "Hull" lot of time in attempting to widen narrow "Lanes" and straighten crooked turn-"Pikes," you have marched up to the Highway Commissioner's office on "Wash Day," with the rest of the "Hale" and hearty Highway Engineers, with your elaborate plans, and presented your "Card." If this happens to be your first experience at his office, you have learned to your sorrow that our State Highway Commissioner will approve anything but an elaborately finished plan with the proposed alignment and grade inked into a hardwood finish In fact, he "Wilcox" up most any kind of a scheme to work in one of "Hoyt's" clothes line curves, or blow your plans full of "Augur" holes before you leave. He works on the theory, especially with amateur highway engineers, that your best efforts of to-day will appear crude and unfinished in your own eyes on the morrow, and, therefore, the "Lee"-way which he furnishes with an opportunity for another attempt, before he sets his stamp of approval on your plans, is not such a throw-down as it at first appeared to be.

You would, no doubt, have made more rapid progress with your highway contracts, if you had consulted your Chief Engineer more frequently and obtained his advice to first submit your plans to the Highway Commissioner with your proposed alignment and grade in pencil and let him do the inking in act. The experience which he has obtained by riding over our one hundred and sixty-eight towns in ox-carts, hay-wagons and automobiles, or by hoofing it if he was short of "Nichols," or "Wadsworth" showing to pay the necessary freight, for the past nine years has placed him in a position to appreciate the difference between a 3 and 6 per cent. grade, or a 1 and 10 degree curve.

What our State Highway Commissioner is aiming to accomplish is the substitution of endurable macadam pavements for our "Brown" "Bacon" colored highways, and if he is not "Beach"-ed by the storm or driven into an "Eddy," I have no doubt he will continue to increase his mileage each year, and the coöperation between his department and the Connecticut Society of Civil Engineers will tend to make each year's work easier, and the completion of your contracts on time more certain.

HYDRAULIC ENGINEERING.

If that 40 below zero wave hadn't struck in near the finish, I expect that you Hydraulic Engineers would have had occasion to put on "Ayers," as your contracts were well advanced previous to that "Frost."

But that frigid visitor gave you a "Peck" of trouble. Water meters were frozen in nearly every "Wood"-en "Hall." They kept coming in bunches until they reached the "big 400." "Bishops" and "Brinsmades," "Richards," and "Ryders" were kept on the move while it lasted, and the rest of us are satisfied that if your work had not been "Welton" previous to that time the list of fatalities of the various pipe and water meters would have been much greater.

MUNICIPAL ENGINEERING.

I have unlimited sympathy for our members engaged in municipal engineering work, and I am greatly surprised that any of your contracts for the year 1903 are completed. Your cup of trouble has probably been as full if not "Fuller" than that of any of your associates, and you were "Gladding" enough when the old year was forced aside by the new. I think I can imagine a few of the kicks which have "Buck"-ed up against you during the year, and which you had to put up with, as you could not a "Ford" to do otherwise without sacrificing either your job or your engineering dignity.

The first man who dropped into your office at 7.59 A. M., had trouble in his barn. The sewage was setting back into his cellar and it was two or three deep when he left. Knowing that the elevation of his cellar was many feet higher than the street surface in front of his house, you naturally asked him if the sewage was up to his neck when he took the trolley car for his morning ride down town, but this query did not satisfy him, and nothing would, except your promise that "Kellogg" or "Fred Jackson" would be up to his house before he reached it. You knew that you were throwing away car fare when you made him that promise, and you found just what you expected, that his barn connection was stopped up and his own roof water ponding behind it.

The second caller had just driven in from the north end of the town and when passing through Trouble street, saw the iron cover of a manhole (weighing from 50 to 100 pounds) dancing up and down in the air, two or three feet above the surface of the ground, on top of a column of water which was belching forth from the manhole, like a young geyser. This being a new hydraulic phenomenon, you thanked him most courteously for the information and recorded it in the archives of your memory.

The next caller had sewage pouring out on the roof of his three-story building from the conductor pipes. This was a sure case of appendicitis and you hustled "Roscoe" or "Charlie Farnham" off with his surgical instruments (pick and shovel), and after making the incision it appeared that Mr. "Trustworthy," in laying the drain, had left a good sized hammer in the "sharp curve" exactly under the curb where it could be readily found if ever needed thereafter. While all of your lieutenants were racing back and forth over the city in the pouring rain, your telephone was buzzing away with similar complaints. These were a few of your experiences during the passing of the storm.

It doesn't make a particle of difference in the results whether you used "Kutter's" or "McMath's" formula, or .011 or .013 for the "co-efficient of roughness," if the sewer won't carry off the water it isn't large enough. The criticisms of the public are based upon common sense and they know whether a sewer is of sufficient capacity or not, when the first downpour appears, and no combination of explanations and computations which an engineer can devise will convince them otherwise.

You have had many other troubles of a similar nature in executing your various contracts.

When the critic used a two-cent postage stamp to write that you had made a mistake of .8 of one cent (8 mills) in his assessment, it perhaps did not occur to you that the great principle of the difference between right and wrong was involved and that many men would rather spend a small fortune than be defeated in what they believed to be right.

As this great discrepancy resulted from the difference between the deeded frontage and the occupancy of the grantee, and knowing the natural reluctancy of grantees, when they become grantors, to deed even what they have occupied if it happens to exceed their deeded frontage, you decide to pay the difference out of your own pocket and close the deal rather than to go to court over less than a penny.

RAILROAD ENGINEERS.

Our Railroad Engineers have had a "Terry"-ble busy season and I cannot complain because many of their contracts remain unfinished.

They have been "Berrian" an innumerable number of ties, steel rails, and a large amount of money in carrying out their great projects. They have a sort of "Spencer"-ian way of executing the details prescribed by the "Ingersoll"-"Curtis"-"Gagel" combine, which sets a 60-mile per hour pace, and keeps the public continually guessing as to what they are going to do next. One trouble with our steam railroad engineers is the fact that insufficient publicity is given to their plans in advance of their different moves. But they have had their troubles as well as the rest of you. Bridges which had been in use for years had to be replaced by stronger structures. The old 50-foot per mile grades had to be reduced to a maximum of thirty feet per mile, and sharp curves had to be replaced with flatter ones to accommodate the tremendously heavy twentieth century traffic.

Grade crossings had to be eliminated and the different road beds ballasted to keep up with the terrific pace set by the "Pensy." Is it, therefore, reasonable to expect that these great changes could be consummated and the final vouchers submitted in a short twelvemonth's period?

CONCLUSION.

Of "Corson" general principles you may expect that I am going on in this manner and examine each of your contracts in detail before approving your final certificates. "Owen" to our limited time, however, I hardly feel that it is "Wirth" attempting.

I am satisfied from my brief review of your work that you have all had your troubles during the past year and a liberal allowance should be made for the difficulties you have encountered in executing your various contracts.

I think we can all agree upon this fact, however, that while very few, if any, of us have actually accomplished what we set out to do at the beginning of the year 1903, we have all contributed our best efforts to the various enterprises we have been engaged in, and have tried conscientiously to maintain our professional dignity and satisfy our constituents.

We have also endeavored, as members of the Connecticut Society of Civil Engineers, not only to preserve the high standard set by our predecessors, but to place its reputation upon an even higher plan of efficiency and thus increase its sphere of usefulness.

Our best efforts, however, of 1903, should appear crude and unfinished as we glance back at them in 1904, and the hard blows which we have received while carrying out our 1903 contracts, should help to round out our professional careers and fit us for deeds of greater usefulness.

Having satisfied myself that the citizens of the State of Connecticut have been fully protected from all loss and indemnified for all damages for which you may be liable, under your individual contracts, I hereby certify that there is now due to each and every member of the Connecticut Society of Civil Engineers the highest praise and commendation, the same being the full and final payment for your valuable services for the year 1903, upon this my final acceptance of the whole work.

THE CONNECTICUT SOCIETY OF CIVIL ENGINEERS,
By FREDERICK L. FORD,
Chief Engineer.

Signed, sealed and delivered in the presence of
HENRY ROBINSON BUCK.
"United States Volunteer Weather Observer."

MR. ALDERSON: I move that the President's address be accepted and printed in our next report.

Motion passed.

PRESIDENT FORD: I would like to make an announcement right here. The preliminary exhibit of the Department of Horticulture, Connecticut Commission to the Louisiana Purchase Exposition, is open at 197 Asylum street, and all those attending our convention are cordially invited to go there and inspect the exhibit.

MR. GRAVES: Mr. President, there is one thing which occurred to me that I would like to suggest, and that is that the constitution with the amendments up to date be printed in the next annual report. I think it is a great deal more convenient to have the constitution in each annual report, and I would move that the constitution and by-laws be printed in the next annual report, corrected up to date.

MEMBER: I second that motion.

PRESIDENT FORD: Motion is made and seconded that the constitution and by-laws as amended to date be printed in the next annual report.

Motion passed.

MR. BUSH: I would like to move that the Secretary have printed and distributed to members a small book containing the constitution and by-laws, and also a list of members. Such list shall give date of admission, address and an indication at the names of past and present officers showing the office held and the year such office was held.

[illegible] Mr. President, I would like to ask if the idea is that this be printed alphabetically [illegible] it will have to be reprinted each year and that would cause trouble.

Mr. Buel: [illegible] doesn't matter either way. But the whole is to be bound in some convenient form to be carried in the member's pocket and then when we go on a summer meeting and meet strangers and learn their names we can indicate it in our book and in that way we will remember them. We have a list every year in our annual report, but that doesn't give us what we want, for we can't have it with us always.

[illegible]: I second the motion.

Mr. Brown: Mr. President, it [illegible] seem to me it is hardly worth while to publish this in book form. It will cost considerably and then again in book form it might have to be revised year after year. It seems to me that we would not [illegible] such a large financial proposition [illegible] same year that it wouldn't be wise. There might be some changes and next year it could be done in book form.

Mr. [illegible]: It seems to me this is unnecessary. We have the whole thing in the [illegible] and we [illegible] other little book to get lost and [illegible] keep track of these little books, but [illegible]

President [illegible] the question.

Motion lost.

Mr. [illegible]: I [illegible] that this Society might do something [illegible] engineering [illegible]. Some of us have very small libraries [illegible] public libraries [illegible] by this Society [illegible] State Libraries Committee and it would have weight. The Connecticut Public Libraries Committee is appointed by the Board of Education [illegible] public libraries as wish [illegible] them. There [illegible] books suggested by [illegible] and other ways. [illegible] engineering problem. [illegible] list of engineering books. [illegible] a list presented by this Society [illegible] welcomed and would have weight [illegible] recommendations to the [illegible] bring it before them. [illegible] the Hartford Public Library [illegible] Committee in regard to the matter [illegible]

[illegible]

[illegible] prepare a list of [illegible] presented as a recommendation [illegible] Committee and to be followed [illegible] required.

[illegible] the motion.

Mr. [illegible]: In my opinion [illegible] idea and I hope the motion will be carried.

Mr. Snell: I also would like to second this motion and it seems to me it is in line with the thought that we ought to try and do what good we can to communities as well as to ourselves. It seems from what Mr. Owen said that the machinery is already in motion. It is the office of the State Library Committee to suggest and recommend books to the different libraries. I know libraries have frequently consulted with individual scientists in regard to books, and it seems to me that if we suggest a list of the most practical and worth while literature in engineering, it would be a good thing and it would seem to be our duty to so do. I hope the motion will prevail.

Mr. Bunce: It seems to me, Mr. President, while I am heartily in sympathy with the main idea of the resolution, that there is perhaps a better way of operating than the one suggested. And I say that instead of the chair appointing a committee of five the matter be referred to the Board of Direction that members of the Society may suggest any work or book to them and then that the board shall consider and make recommendations from the works presented by the members. I will move that the motion be amended so that it will read in that way.

Member: I second the amendment.

President Ford: I will ask Mr. Owen if he will accept the amendment.

Mr. Owen: I will accept it.

Motion was then passed as amended.

Mr. Clark: On behalf of the Committee of Arrangements I would like to request all those local members who kindly volunteered to assist in entertaining over night to see to it, that if they haven't already secured any particular member, they will try and do so soon.

Secretary Jackson: I have a little matter I would like to bring up for the consideration of the Society. In fact, I have two matters. When I first took the office of Secretary, in looking over back reports of the Society, I saw scattered through them in several places obituary notices concerning different members who had passed away. In speaking to my predecessor in regard to writing these notices I was told that the Society had grown to consider obituary notices obsolete, and that all mention in that form of the decease of brother members had been dispensed with by vote of the Society.

Now, I would like to bring it before the Society at this time and get an expression in regard to the matter, because it seems to me it is certainly unchristianlike to let a member pass out from our midst without even at times the Secretary knowing of his decease. There was Mr. Atkins, one of our oldest members, and no notice at all of his death has come to the Secretary. It would not have appeared in your minutes except Mr. Bunce vouchsafed the information. It seems to me something should be done. If it does not take the form of an obituary notice it might take the form of a committee appointed to draw up resolutions of sympathy or something of that kind. I think the position of the Society in taking no notice of a brother's decease and of letting him pass out from our midst without any expression of regret is wrong. I hope the Society at this meeting will take some action looking toward changing that form of procedure.

The other matter is this circular from the Committee of the American Society of Civil Engineers on the St. Louis Exposition.

St. Louis, Mo., Sept. 1, 1903.

To the Connecticut Society of Civil Engineers, New London, Conn.:

The American Society of Civil Engineers has appointed the above named Committee to represent it at the Universal Exposition to be held at St. Louis in 1904, to commemorate the Louisiana Purchase.

It is the purpose of the Committee to collect and present an exhibit of plans, photographs, models and descriptions of American engineering works, principally work designed by members of the American Society, which it is believed will be of great interest both to laymen and engineers. It is intended also to make the headquarters of the Society, which will be in the Liberal Arts Building, a center of information as to other exhibits in the Exposition which may be of engineering interest. There will also be a register which will help one to find and meet his friends, and it is hoped that the headquarters may serve as a rallying point and rendezvous for all visiting engineers.

The members of the Connecticut Society of Civil Engineers are cordially invited to avail themselves of the conveniences to be provided by our Society during their visit to St. Louis and the Exposition, and it is hoped that a large proportion of them will be able to do so.

By order of the Committee.

H. J. Pfeifer,

Secretary.

This communication has been received, presented to the Board of Direction and by them voted to be read at this meeting.

President Ford. What disposition will you make in regard to these two matters of the Secretary.

Mr. Kellogg: In regard to the obituary notices, I move that the Secretary insert in our next annual report a notice properly worded of the decease of our brother member, J. P. Bogart, and that he be empowered also to write a short account of Mr. Bogart's career.

Member: I would amend so that the motion will be that the Secretary prepare a list of those who have died, give particulars regarding their birth, etc., and publish that list each year in the report.

Mr. Cadwell. I would like to add that the same apply to Mr. Atkins that Mr. Kellogg suggested in regard to Mr. Bogart. It should also apply to any other deceased member.

Mr. Kellogg: I will modify my motion so that it will take in all.

Secretary Jackson. I would like to further amend that motion to this effect. Now the Secretary can obtain the information that it has been suggested he could; but it seems to me the rule in most bodies of this kind is, that when these matters are taken up they are generally referred to some committee and that committee is usually composed of intimate friends of the deceased, and they are supposed to be so well acquainted with him that they are better able to write a notice than is the Secretary, who has simply received the information. And I think the best method to pursue along this line is to appoint a committee each time and have that committee present resolutions, not only to the Society but to the family of the member as well.

President Ford: You would do this at each successive meeting?

Secretary Jackson: Yes, now that we have a two days' session.

Mr. Kellogg: Perhaps I did not explain myself clearly. I believe one man can do as well as three.

President Ford: Did you offer that as an amendment to the original motion, Mr. Secretary?

Secretary Jackson: I did.

Member: I second the amendment.

Mr. Bunce: Mr. President, some years ago I had occasion to put myself on record in matters of this kind and I must confess that personally I am of the same mind as I was then. I heartily agree with the motion as made by Mr. Kellogg that a notice should be spread on our minutes with a short account of their careers when a member has died, but when you go beyond that, I say, personally I am not in sympathy with a set of resolutions, for I am led to believe that they are so largely matters of form and to a great many people almost meaningless in that they are generally drawn on such similar lines, that they never appeal to me at all. I do think some account should be published of the lives and work of our members after they pass away from us, but I don't believe in embodying it in the form of resolutions.

Mr. Tracy: I don't think Mr. Bunce is alone in that. I think there is a growing dislike against these formal resolutions.

President Ford: Mr. Kellogg, will you state what you understand your motion is with the amendment.

Mr. Kellogg: My motion with the amendment is this: That a committee of necrology be appointed by the President to seek out and obtain, either by themselves or of anyone from whom they can get it, sufficient information to write a short account of each deceased member's life or career.

President Ford: You have heard the motion as amended.

Motion as amended passed.

President Ford: The tellers are now ready to report the result of the letter ballot.

Mr. Spencer: For President, there were 101 votes cast, of which Mr. Punderford has 45, Mr. Geo. K. Crandall 38, Mr. F. L. Ford 12, Mr. A. B. Hill 3, and the rest scattering.

President Ford: As there is no majority the ballot becomes informal and you will cast your vote for President.

A ballot was then taken and there were 57 votes, of which Mr. Punderford had 41 and Mr. Crandall 16.

Mr. Corson: I would like to move that the election of Mr. Punderford be made unanimous.

Passed and cries of "Speech," "Speech."

[illegible] you are asking for any spontaneous utterance of what the future will be it is impossible at such short notice to give it; but I desire to thank the President and the members of this Society for the honor [illegible] upon me in electing me President. I can only say I will do everything in my power to further the interests of the Society during the next year. I ask the sincere cooperation of each member in order that [illegible] the Society during the coming year the high standard that has been set by our President, Mr. Ford.

President [illegible]: The [illegible] will now read the result of the vote for First Vice President.

The Secretary: [illegible] which [illegible] Ford has [illegible] [illegible] Secretary [illegible] and the rest scattering.

[illegible] that the Secretary be instructed to cast a ballot for the [illegible] having the highest number of votes on that list.

[illegible] Seconded [illegible]

President [illegible]

The [illegible] an excellent one, but is there [illegible] [illegible] accept it.

[illegible] was speaking to Mr. Ford the [illegible]

President [illegible] office.

[illegible] with Mr. Ford the results [illegible] was not acted [illegible]

[illegible]

President [illegible] will have for [illegible]

[illegible] which Ralph [illegible]

President [illegible] Second Vice [illegible]

The Secretary: [illegible] Ford had [illegible] the rest scattering.

President [illegible] prepare your ballots [illegible]

[illegible] seconded.

President [illegible] election of Secre-[illegible]

[illegible] Jackson has [illegible]

[illegible] election of Direc-[illegible]

[illegible] J. M. Jarvis [illegible]

[illegible] as Director for [illegible] better to [illegible]

MR. KELLOGG: Mr. President, we have got something to say about this matter. You must not think just because you have been President that you can draw out. The President has been put on the Board of Directors before and the Society wants you. The only mention I ever heard about the number of Hartford men being on the ticket came from Hartford. There is no electioneering for any city or any town in our Society. If there is anything savoring of local matters drop it. I know the Society wants you.

PRESIDENT-ELECT PUNDERFORD: I would like to ask the members to insist upon Mr. Ford taking this election.

PRESIDENT FORD: I declare Geo. K. Crandall and C. M. Jarvis elected Directors.

MR. KELLOGG: Mr. Jarvis is all right, but I don't see how you can declare him elected.

PRESIDENT FORD: Doesn't the withdrawing of the first man elect the next two?

PRESIDENT-ELECT PUNDERFORD: Mr. President, will you not kindly reconsider your withdrawal; we should like to have you serve and we should like you to declare this election as the members have made it. With the permission of the members I would like to take the chair for a moment. It is altogether unusual and unparliamentary I know, but if you will withdraw from the chair for a moment I would like to take it. (Mr. Punderford takes the chair.)

Gentlemen, if no one objects I will preside for a moment, and unless Mr. Ford adheres to his expression I declare Mr. F. L. Ford and Mr. Geo. K. Crandall elected Directors.

(President Ford resumes the chair.)

MR. CHANDLER: We have made arrangements to give respect to the dead. Now, I think there is one of the living who, perhaps, ought to be considered at this time. I don't know as there has been a great deal said about the twentieth anniversary of the existence of our Society, but this is the twentieth annual meeting. And away down in Bridgeport is a gentlemen who was not very young twenty years ago, but who was practically the founder of this Society. He is not able to come to the meetings any more, but I do not doubt that he is thinking of us to-day.

I would move that the President of this Society send this tele gram to Mr. Hull: (Following is the telegram as afterward amended by Mr. Bunce): "B. H. Hull, Bridgeport, Conn. The Connecticut Society of Civil Engineers assembled in Hartford, two hundred and twenty-five strong, send greetings to the founder of the Society on this twentieth anniversary."

MR. BUNCE: Mr. President, Mr. Chandler has rather got the start of me in that I had proposed at the banquet this evening, as I noticed the toast to be responded to by Mr. Kellogg, that at that time the Society should drink the health of the founder and first President, and send the hearty congratulations and good wishes. But I don't wish to stand in the way of this motion at this time.

[illegible] I would be very glad to withdraw and do it as you say.

[illegible] I move that that telegram be amended by adding the words "two hundred and twenty-five strong."

[illegible] accept the amendment.

[illegible] as amended was then passed.

[illegible] I would like to bring up and [illegible] Seymour Marshall [illegible] honorary member and I think [illegible] I would make [illegible] meeting that Mr. W. [illegible] Seymour [illegible]

[illegible] done without [illegible] want to be corrected.

[illegible] Society [illegible]

[illegible]

[illegible] Society [illegible]

[illegible]

[illegible] Secretary.

[illegible]

[illegible] amendment to the [illegible] amendment to [illegible] The [illegible]

[illegible]

We cannot fail to appreciate the monumental work in road construction which the Hon. A. C. Sternberg did for his own town of West Hartford. He was one of those who not only believed in the improvement of our highways, but had the necessary tact to interest his townsmen sufficiently to carry out his carefully detailed plan. I have no doubt his practical demonstration in permanent road construction so close to our State Capitol helped to pave the way for the organization of our State Highway Department.

I have also always had a great deal of respect for the third member of the Commission, the Hon. Wm. R. MacDonald of Cromwell, and I have no doubt these two Commissioners were of great assistance to the State of Connecticut in getting the good roads movement properly started and in helping to overcome the large amount of lukewarmness which at first confronted them.

But to our present Highway Commissioner must be given the credit of shaping and rounding out our highway system to its present condition of excellence. By his persuasive and persistent efforts he has at last succeeded in inducing the few remaining towns to come into the fold, so that to-day he stands with a united front of one hundred and sixty-eight towns.

The distinguished reputation he has gained as the head of his department has not been obtained by a lavish expenditure of the State's money, but by securing maximum results from minimum expenditures.

"MacDonald's Model Macadam" is now recognized as the standard of America, and all the States which have taken up this great subject are endeavoring to reach the high standard he has set.

I take great pleasure in presenting at this time the Hon. James H. MacDonald, the father of "MacDonald's Model Macadam" and of the good roads movement in Connecticut.

Mr. MacDonald's paper is printed on page 53.

PRESIDENT FORD: I am sure we have all been delighted to hear to-day, as we always are, from our State Highway Commissioner. We are all so close to him that we somehow feel as though we were equal shareholders in whatever has been done throughout the state.

The motion is made and seconded that we extend to him now a hearty vote of thanks for his address.

Motion passed.

PRESIDENT FORD: Take that home with you, Commissioner.

The meeting then adjourned to meet at the Hartford Club at 6.30 for the banquet. President Ford announced that all those interested in the drawings and the model of the new Hartford bridge might see them at President Graves' office, which was kept open for the convenience of the members.

[illegible]

[illegible]

[illegible] have now reached that [illegible] that the succeeding [illegible] own for the [illegible] appreciation [illegible]

[illegible] Society of Civil Engineers [illegible] many men [illegible] of the Society [illegible] convention of our Society [illegible] it does the begin- [illegible] and the holding of the [illegible] that the success [illegible] which are to follow [illegible] our Society [illegible]

[illegible] that we are unable to [illegible] with us to-night. He [illegible] his death, [illegible] him here, but the [illegible] business men [illegible] invitation. [illegible] a message [illegible] and he would [illegible]

[illegible] matter and [illegible] membership [illegible]

[illegible] and [illegible] present and when [illegible] the evening [illegible] and [illegible] that [illegible]

[illegible] nothing that [illegible] that [illegible] accomplished, [illegible] profession. [illegible] of the last [illegible] commissioners being held up and not passed upon for eleven months, and I can recollect I was walking through Keney Park and saw an engineer coming toward me looking happy and contented. He had an old felt hat on the back of his head, trousers were rolled up, arms bare and sunburned; but what caught my attention most in the frame of mind I was at that time was the fact that behind him strode a fellow at the end of a string; this fellow had a bunch of sticks on one shoulder and on the other he carried an axe. And I thought, as my mind wandered back a little way, that there had been times when I wished I might have been an engineer's helper and carried an axe.

Several times during the last few months I have received communications from gentlemen who wished me to intercede for them that they might secure a situation. Now, you all know that we are building a big bridge here over the Connecticut River, between Hartford and East Hartford, and the burden of these letters was that the men would like to secure positions as inspectors of the work. So meeting the chief engineer, Mr. Graves, one day, I spoke to him about it and he said, "My Mayor, this is something new for this part of the country, building a bridge of this kind; and we are not going to employ any ordinary inspectors or laborers, we are going to have only competent engineers do this work." And I have been wondering ever since whether Engineer Graves was going to establish a civil service bureau or build up a political machine.

Here with us to-night are men from various parts of the country, and in speaking to one of them, whom I hope we shall have the pleasure of listening to shortly, I said he would find Hartford a very fine city and that we have a faculty for giving very good dinners. "Why," says he, "I don't wonder at that; you've been a long time at it." But even though it be so, I think we in Hartford have very much to be proud of, and looking back, do we here in Hartford realize that we live in that portion of the country where you can find more people in one day's travel than in any other part of the United States? Within a few hours' ride of Hartford we have seven million people, and when we think that Hartford and a few hundred miles surrounding is so small a section of this great country we will fully realize our importance.

We have sent out from our midst to other parts of the United States men who have been pioneers, who have taken with them the lessons received here and who have made their mark in other parts of the land. So, perhaps, our greatest asset is the sterling citizenship found in Hartford. Our men can overcome the greatest obstacles and reach the pinnacle of fame. I believe the capital city of Connecticut is the greatest city in the United States, for we have here men in all classes, in all businesses, and men who are known for their worth throughout the country. And I trust that your honored guests here to-night will receive such a reception that when they go to their far-away homes they will say the capital city of Connecticut is well worth our highest appreciation and deserving of all the good things which have been said about her.

PRESIDENT FORD: We have a distinguished gentleman here to-night from Washington, D. C. He is Uncle Sam's Good Roads representative.

[illegible] man, and except for his being [illegible] I am afraid we would not have been able to obtain him for this evening. [illegible] very good reasons for not missing these [illegible] and I am going to ask him to tell us why he never [illegible] good roads convention—the Hon. Martin Dodge, Washington, D. C.

Mr. Dodge: Mr. Toastmaster, and Gentlemen of the Connecticut Society of Civil Engineers: [illegible] should be called upon [illegible] taken somewhat by surprise. I am reminded [illegible] toastmaster [illegible] introduction [illegible] what the [illegible] Dodge [illegible] dodged [illegible] but he couldn't [illegible] the devil [illegible] might as well try to dodge the [illegible] good roads convention. They are exceedingly interesting to me.

I was [illegible] good roads convention in Boston, [illegible] its annual dinner. I was [illegible] these gentlemen, and I can assure you [illegible] It was [illegible] meeting was held in the city of Washington [illegible] delegates [illegible] from [illegible] were [illegible] Congress, a resolution passed [illegible]

[illegible] good roads convention [illegible] Columbus. [illegible] The [illegible] the entire state [illegible] congress at the same [illegible] convention. I [illegible]

[illegible] from Senator Latimer [illegible] Senator Latimer [illegible] government. [illegible] I am [illegible] coming forward [illegible] this kind. [illegible] and other [illegible] proposition which [illegible] Senator Latimer [illegible] measure [illegible] the good [illegible]

[illegible] great length of time [illegible] the government [illegible] and [illegible] exceedingly inter- [illegible]

I was greatly pleased with the remarks of your Mayor in regard to the work of the state and what good things it has done and inspired. In my remarks at Boston I was glad to say that the good example being set by their highway commission, as well as their ability and the plan of state aid, was really a very great service to the nation and not only to their own state.

PRESIDENT FORD: Gentlemen, from your experience thus far this evening, all of you who think February 9, 1904, a red letter day in the history of our Society, say aye. (Unanimous.) I also assume the distinguished guests we have with us to-night will mark the days of February 9, 10 and 11 as red letter days in the history of the good roads movement.

The next red letter day comes on February 14th, and is familiarly known as St. Valentine's day.

We have with us to-night a distinguished Michigander. I am inclined to believe, as I look him in the face, that he is a crooked fellow; but my experience with him so far does not justify me in saying so. He was one of the earliest workers in behalf of highway improvement and I understand he is a red-hot good roads man and one of the most prominent in the country.

While he is undoubtedly full of good roads information, I understand he also knows something about St. Valentine's day and I am going to ask him to tell us just what he knows about St. Valentine's day.

I take great pleasure in presenting Horatio S. Earle of Michigan.

MR. EARLE: Mr. Toastmaster, Gentlemen of the Connecticut Society of Civil Engineers and Friends,—It is true that I look crooked, but there is a difference between me and some politicians and the difference is that I look crooked. They think it is quite fashionable out in my state and some of the politicians have been trying to look crooked, for they are the fellows they always send to the legislature.

It is also true I know something about St. Valentine's day. My good friend, Commissioner MacDonald, whom I address as "My dear Tutor" and sign "Your faithful Pupil," promised me fair and square that I would have an opportunity to sit and listen and enjoy one banquet at which I would not have to hear my own voice.

My good mother-in-law and I don't agree on what is going to happen when we get to the Happy Hunting Ground. She has got an idea that we are all to sit around in a circle and sing everlasting praises during all eternity. I told her if I had got to go to heaven and sing and have this same voice and have these same ears, I would rather go to the other place. And I thought I would not have to hear myself talk to-night, but when your President, Mr. Ford, wrote me that I would be expected to respond to the toast, "What I know about St. Valentine's Day," that relieved me of any very extended thought because I have only got to tell you how it happened. And while I am a Michigander by adoption, I am a New Englander by birth and rearing. I was born and raised up here in this old State of Vermont on one of these hillstown farms. And when I tell you that, it is sufficient to make you believe my father was not very rich in this world's goods.

Well, my mother had the same ambitions and the same desires other mothers had. [illegible] back long ago. I have heard it said, in the year 18[illegible] she [illegible] Christmas present. She desired it as much as any mother ever desired a present on Christmas. The day came and went [illegible]. Then she, like all good women, thought [illegible] she would get a New Year's present. The day came and no New Year's present [illegible] you know of the 14th of [illegible] 18[illegible], but that [illegible] did not forget my mother, [illegible] where they get all valentines and [illegible] and He sent [illegible] and while this face is pretty homely [illegible] and I had to take this face [illegible] while these eyes are pretty [illegible] had to take them [illegible] engineering, because [illegible]!

[illegible] who governs this city [illegible] office [illegible] stay [illegible] want [illegible] that gives you a [illegible] are summer senators [illegible] and took [illegible] right of immigrants [illegible]

[illegible] not graduate from [illegible] architect and builder [illegible] was the first teacher [illegible] was and when [illegible] commander

[illegible]

the river, etc., better than I can Greek or Latin. It seemed to me that the handle of that pickaxe was symbolic of capital, useless without labor. It seemed to me as I looked at that pickaxe that the larger part of the material in the pickaxe was symbolic of unskilled labor, of which there is a great amount in every state in the Union. And it seemed to me that the points of that pickaxe, being able to go both ways, were symbolic of my eyes, and not only that, but they were symbolic of civil and mechanical engineering. It is a great benefit to every state in the Union that it has such men as engineers to make straight the crooked paths, and make smooth the ways. And it seemed to me that with your education you ought to not only lay out and direct the work, but you ought to have an influence upon that uneducated larger class of laboring men and the men that have the capital, so that capital and labor may work hand in hand in all good works as the pickaxe does in the hands of a good laborer.

President Ford: Among my many duties as toastmaster this evening I have one which I will take the liberty of doing at this time. I suppose you will think it is a little late for a Christmas present, but I have one to present, and I am going to present it now.

At our business meeting this morning the Hon. William O. Seymour, Civil Engineer and Railroad Commissioner, was unanimously elected to honorary membership in our Society, and I take this opportunity of presenting the membership to him, and I would like to have him stand, that you may all see him, then you will always know him by sight.

Mr. Seymour: Mr. Chairman,—This is a genuine surprise to me. I was not aware I had been made an honorary member of your Society. To begin with, I want to thank you all personally for extending to me an invitation to be your guest on this occasion. I appreciate the privilege very much, and am sincerely grateful to you for it. I wish to congratulate the retiring president of the Connecticut Society of Civil Engineers for the very flourishing and prosperous condition of the Society. Certainly it is very fit and proper that the engineering profession should get together and discuss and talk over important questions concerning the work in which they are engaged. The medical profession do this; the legal profession do, and certainly the engineers should do the same thing; and I rejoice that this Society has grown and prospered until it has arrived at its present splendid condition.

I want to say another thing to the younger members of the profession, just a word only. It seems to me that the tendency during these modern times is to specialize. It is so in the legal profession; there is the corporation lawyer, the patent lawyer and the various branches of that profession. It is the same in the medical profession; we have the doctor, the specialist in different diseases, and the work is divided up. The time was when the civil engineer was expected to spread himself out over all the various branches of his profession. But things are now changing, and I believe the only way in which a young man can make himself excel in his work is to devote himself entirely to one single branch of [illegible] thing then that the technical [illegible] are interesting for the technical student [illegible] engineering [illegible] the mechanical engineer and the [illegible] particular branch [illegible]

[illegible]

New Haven paper, how it seemed to be the wife of a man so much older than she, and she replied: "Why, really now, when my husband kisses me I feel as if old age was falling gently over me, don't you know." So, to-night, being officially rated as an "Old Guard," I imagine that old age is grasping me; perhaps warningly, lest you should get onto my O. G. curves.

To aid me in recalling those old days, Mr. Graves kindly loaned me his complete file of reports. It is said of newspaper men that, when they get their papers, the first things they look for are their own contributions. Me too. For, as I went over the reports I looked first for records of my own doings. For the first three years Chandler was first, and I was second vice president, but of what I said or did nothing appeared, that I noticed, until nearly the end of that period. There it stated: "On motion of Mr. Kellogg the meeting adjourned." That settled it. At the next meeting Chandler was elected president. Whether I pushed Chandler, or he pulled me, is a question I do not care to have discussed. But I am obliged to state that when Chandler vacated the chair, at the end of the year, I was lost in the shuffle. If he had me under his wing I think my head and feet must have stuck out. To make up for this neglect in my younger days, many years later I was again made first vice president and then president. I mention this to show that no member should think he has a divine right to a term as president until he has served at least three years as second and two years as first vice president. Jacob's record of ten years' service, merely to get two wives, and one of them forced upon him, got a jolt; but it had stood as an example of perseverance for thousands of years and it was time for somebody to jar it.

When we consider those of the "Old Guard" who have stuck closely to the Society, regularly attending meetings and contributing papers and joining the discussions, and arranging for and carrying out excursions, we cannot thank them too much for their devotion to the cause. The most deserving of them is Bradley H. Hull, the father of the Society. All of the O. G. salute him as their chief. When he gave this Society its existence he was nine years older than I am to-night, and I have passed the half-century mark, and the boys in our office call me a back number. The virility of the man, his optimism and enthusiasm, and withal his kindly, generous nature, as shown by his record, and as we know him, call for our admiration and affection; and I need not ask you to know that such is your feeling toward him.

The time is too limited to speak of more than a small portion of the men who bore the heat and burden of those old days. Chandler, the first man to make a blue print on cloth, so far as I know, I have already spoken of. My closest friend, Weld, died in his prime.

There is that old war-horse Bunce, who has worsted me in so many debates that I now wait until I see which side he is on before I say anything. He may dispute with Chandler the record of having attended more meetings than any other member. Jarvis was a tower of strength in those days. It used to do my heart good (and it resulted in improv-

misurement for that rock, its harrue and twisty." I tried to explain that the cut rock was to be shown on the map and an over-measurement at any place would be noticeable. "Well, well, now," said he, "I don't want ye to hump it up in anny one spot, but shcatter it along."

One is tempted in these circumstances to say a word to the younger members—to get fatherly and get left. Washington engaged in civil engineering and so did Jay Gould, and I recently read of a civil engineer serving a term in state's prison. So there are chances for all of you. What applies to the civil applies just as well to the other branches represented in our body. Keep up and increase the numbers at these meetings and incidentally help to boom Hartford. Here is a result, before your eyes, of our annual meetings in this city. The "Good Roads" people from all over the country, one thousand strong, are swarming here and sending up the price of provisions. This city is full of history. I was born here. Terry McGovern and young Corbett fought here.

Gentlemen of the Society, I will close with a message from Mr. Hull. This Society has been like a beloved child to him. As it were from a kind and loving father, whose labors are over and whose sojourn on earth is nearing its end, he sends you his blessing.

President Ford: I once asked a friend of the highway commissioner, "How does MacDonald get his wonderful pull?" "Well," he says, "Mac has a pretty level head and it doesn't make any difference where he goes he has always got a smile for the children, and that makes the mothers happy. Why, if Mac was running for any political office he would have one of the greatest ladies auxiliary organizations going that ever was." I have the pleasure now of presenting Hon. James H. MacDonald, State Highway Commissioner.

Commissioner MacDonald: (After the orchestra had played, "We won't go home till morning.") It won't be quite as bad as that. I am afraid, gentlemen, that with this convention on to-morrow and this banquet to-night, and after that pleasant little introduction by your President, who is styled the Teddy Roosevelt of Hartford by reason of his strenuous life, that I shall be somewhat like the lecturer going through the West. In one town he happened to pass a drug store, and on looking in the window he saw a lithograph of himself and attached to his chin was that very familiar sign they have at all drug stores, "Open all night."

Now, when your President, Mr. Ford, asked me to speak at this banquet I felt a good deal like the old Scotchman who had been away from home for a number of days attending some meetings. On his return home his wife noticed he had increased his girth and she says, "Sandy, how is it, good mon, that you are so big?" "Well," says Sandy, "you know you gave me when I went away twelve shirts, and you told me I'd have to keep clean and put on a clean shirt every day. I have done it." In other words, he thought he had about enough to take care of. And that's the way it is with me. The pleasure of being with you has brought me here and this perfectly informal occasion is a very happy one for me.

When I was drinking the different toasts I felt a good deal like the man down here along the Shore Line who said to his wife, "Maria, I understand [illegible] the Bible all about the Hebrew [illegible] and [illegible] other things, and get in a revised edition [illegible] and [illegible] get me a revised edition because [illegible] want to see it." He [illegible] until he [illegible] had gone and got that revised edition for him [illegible] came [illegible] he said eagerly, "[illegible] you get [illegible]?" [illegible] answered [illegible] and gave it to him. He took it quickly and began turning [illegible] over with a troubled look on his face. Finally he came to a certain passage, threw up his hands and exclaimed [illegible] thanks [illegible] there!" [illegible] And the [illegible] your stomach [illegible]

[illegible] the [illegible] of the [illegible] we [illegible] day in my travels I picked up a copy of "Puck" and found a picture which to me seemed very real. It showed a farmer who had started for some place and who had, by reason of the poor roads, lost a wheel. The cause was plainly shown by the rut in the road. The farmer was sitting on the bank, while leaning on the fence was another farmer who was made to say, "What's the matter, John?" and John replied, "Why, I was on my way to town to vote on this good roads question and I broke a wheel. There's a lot of city fellows coming up here to make us vote for good roads, but I'm going down to that meeting and vote against it if I have to walk."

That seemed to me such a very strange way of putting it that I sat down with my pencil and wrote this little story. I don't claim for it any poetic merit. It is written for a lesson and is not a specimen of good poetry.

FARMER BROWN'S CONVERSION.

A town meeting was held in a certain town,
And the farmers all came from miles around;
To see what could be done for better roads
To shorten the distance and increase their loads.

The meeting waxed red hot, for all discussed
The great question of ruts, mud and dust.
And after two hours' talk, quiet settled down;
Then up rose rich old Farmer Brown.

"No, sir, we don't want any good roads
To raise our taxes and increase our loads
Of heavy expenses and big bills to pay;
We'll just pass that by for some other day."

So down he sat with a quiet grin
For settling that question and saving his tin;
No one disputed the remarks he had made
And when the vote came, the old roads stayed.

Brown, he forgot the adage, "Every dog has his day,"
And "he who dances has the piper to pay";
But the bitter lesson he learned to his sorrow,
"If we borrow to-day we must pay to-morrow."

Out from the farm at the break of day
Comes old Farmer Brown with his load of hay.
He looked at the road and scanned it o'er,
Then said to his horses, "Ponies, you've got a chore
To bring this hay into old Shingletown,
And get back before night, ere dark settles down."

Farmer Brown was right, the road it was bad.
The mud and the ruts would make anyone mad;
Much more Farmer Brown, who was easily riled
At the slightest trouble,—he was so from a child.

Shingletown is twenty miles from Farmer Brown's,
A rough road over swamp holes up hill and down.
The first ten miles he managed to get through,
But there was still ten more for the ponies to do.

Another mile, and then he came to a hill,
An old corker,—enough to make any team stand still;
But the ponies went at it with a will
And soon had the load at the top of the hill.

Then down they came to the valley below,
Where Farmer Brown began to go slow;
For now he struck a deep, nasty mire,
Where, tugging and pulling, off came a tire.
Down went the wheel, over went the load
Into a deep ditch alongside the road.

Twelve miles from home, eight miles from town,
And not a soul to help for miles around;
Brown tugged and he tore, he fumed and he swore,
He finally gave [illegible] he could do no more.

So he unhitched his horses, which [illegible] away with a dash,
[illegible] headed for home and went like a flash.
As they passed [illegible] the [illegible] Brown sat down with a groan.
[illegible] must own.

[illegible]
[illegible] walked all alone
[illegible] and down
[illegible] to the town.

[illegible] grew
[illegible]
[illegible] did.
[illegible]

[illegible] slow
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

[illegible]
[illegible]
[illegible]
[illegible]

[illegible]
[illegible]
[illegible]

[illegible]

[illegible]

[illegible]
[illegible]

meeting at Bridgeport in 1900. It was the most painful experience I ever passed through.

In the innocence of my heart I accepted a position on the Committee of Arrangements for that meeting at Bridgeport. From the previous gatherings and careful inquiry, we assumed there would be about fifty members present, and made arrangements accordingly. I traveled to Bridgeport several times, making arrangements for the meeting, and I got there ahead of the majority of the members. I made arrangements that dinner should be at Lehmann's, and went through a great deal of labor with Mr. Lehmann in getting up a menu. The menu I wanted had on the cover the raised figure of a large red lobster, and if anyone could have seen the number who showed up at that dinner they might have used that raised figure as a photograph of myself.

I began to think things at the business meeting in the morning at the Atlantic House, when we were skirmishing around for a quorum; and as the time for the dinner began to approach and the members did not my spirits began to wane, and to add insult to injury, when we got ready to take that little tub that goes back and forth from Pleasure Beach to Lehmann's on an endless chain, we found it had broken down and we hustled for rowboats to take us across.

Well, we didn't get to Lehmann's for some time, but when we did I ran for the wet goods department to brew a punch to cheer our fast falling spirits with spirits of a higher proof, rushing to the door on the arrival of each trolley car, looking for the reinforcements that never came. At last, after we had endured the agony as long as nerves could, twenty of the faithful sat down to a bang-up good dinner. The six coons whom we had engaged to sing, dance and play were great, and saved us from what might have been a very funeral gathering. My friend Kellogg certainly enjoyed that dinner, and as I remember it, after the oysters turned his back on the table and led the slaves in their musical efforts. One good point was that my friend, that Sage of the Berlin Construction crowd, was not there to question, as he did at another meeting, whether I was feeding them kerosene, cotton seed, or salad oil.

But enough of this sad episode: I can only wish better luck to the man who tries to run the dinner end of a midsummer meeting.

SECOND DAY, FEBRUARY 10TH.

PRESIDENT FORD: Gentlemen, before beginning the regular program I want to congratulate the Society on the large attendance here to-day. I also want to congratulate the committee on the banquet and selecting the menus.

Yesterday I did not announce the Committee on Necrology. I will do so now. On James P. Bogart, Chas. A. Ferry and A. William Sperry. On Roswell Atkins, William H. Cadwell and Algernon B. Alderson.

PRESIDENT FORD: As you see by our program, the first address this morning is "A New Water Power in Connecticut." I presume our local members remember the suspicion thrown out at the last session of the [illegible] when the New [illegible] Power Company attempted [illegible] great many people in [illegible] County thought [illegible] this power company was owned by New York City and if the [illegible] was [illegible] the water [illegible] New [illegible]

[illegible] the Chief Engineer of the New [illegible] Water [illegible] great pleasure in presenting [illegible]

[illegible]

[illegible] been [illegible] pleased [illegible] which [illegible]

[illegible] New Water [illegible] we will be glad [illegible] pleasure [illegible]

PRESIDENT FORD: I would say it is always a pleasure to have the addresses delivered by our members.

MR. KELLOGG: Our ranks are beginning to thin out and many are going over to that good roads convention. I would like to go myself. If we could finish our discussion and end the meeting, it will give all the members an opportunity to take in all the features of that convention at the Capitol.

I don't wish to interfere with the discussion, but I know many feel they would like to go over to the good roads convention, and if we could finish the discussion now and adjourn they will be at liberty. We have had a fine meeting. We have all enjoyed it and don't want to miss anything.

PRESIDENT FORD: In carrying out that suggestion I would ask if there are any members here who have any wish to discuss the bulletins or papers that have been sent out. It is a new idea this year and I thought it would be best to follow the practice of the American Society and discuss them at this meeting. It has not been as successful as I anticipated because I have not been able to secure as many papers as I would have liked. We have only put out two bulletins, but they were good ones.

MR. BURT: I for one have appreciated the splendid efforts and the result of the work of the Committee on Arrangements. I wish to voice my own individual thought to this effect and would like to put it in the form of a resolution of thanks to the members that have so efficiently done their duties.

PRESIDENT FORD: Motion is made and seconded that we extend a vote of thanks to the General Committee of Arrangements, to the Hartford Street Railway Company, to the Hartford Club for the use of their beautiful building, and to the various reporters for the report of our meetings.

MR. KELLOGG: Please extend one to Commissioner MacDonald and to Mayor Sullivan.

MR. CRANDALL: The engineers of the Bridge Commission have not been mentioned and I think they deserve a great deal of commendation.

PRESIDENT FORD: I would modify that to include the contractors. All those in favor of this blanket vote of thanks say aye.

Motion passed unanimously.

PRESIDENT FORD: I would like to ask if you desire to have any expression of opinion relative to holding a two days' session. What is the sense of the meeting?

MR. BUNCE: It seemed to me this morning when I asked the Secretary how many were here, and he said about sixty, that was a sufficient answer. If we can hold sixty members over night it answers the question.

PRESIDENT FORD: I suppose it is perfectly proper to leave the matter in the hands of the Board of Direction.

MR. SNELL: I think this has been a great success and I had thought the principal feature was to come this afternoon, that is the discussion, for as the President has said it should be a principal feature of engineering work. And I want to express my disappointment that we could not have that and I hope this will not be a precedent for future meetings in this respect. I hope there will be more of these bulletins and that the members will discuss them.

PRESIDENT FORD: Of course, we have had a great deal of experience at this two days' session and will know how to do it better next time. If there is no further business, a motion to adjourn is in order.

Meeting then adjourned.

CONSTITUTION.

ARTICLE I.

NAME AND OBJECT.

SECTION 1.—The name of this Society shall be the CONNECTICUT SOCIETY OF CIVIL ENGINEERS.

OBJECT.

SEC. 2.—The object of this Society shall be the professional improvement of its members; the encouragement of social intercourse among men of practical science, and the advancement of engineering in its several branches, to wit: Civil, hydraulic, naval, sanitary, mechanical, electrical, architectural, mining, geological, metallurgical, and chemical; the reading and discussion of papers, or to hear lectures on any of the above topics relating to engineering science, and the transaction of all business properly belonging to said Society.

ARTICLE II.

MEMBERSHIP.

SECTION 1.—The membership of this Society shall consist of Members, Honorary Members and Associate Members.

MEMBERS.

SEC. 2.—Members must be at least twenty-one years of age and have had two years' actual experience in some branch of engineering or surveying, or shall have been graduated from an engineering course in a college or university of recognized standing, and they only shall be entitled to vote or transact business for the Society.

HONORARY MEMBERS.

SEC. 3.—Honorary Members may be as many as the Society shall elect. They shall have no vote, nor shall they be eligible to hold office. They shall have the right to attend all public meetings and to enjoy such other privileges as the Society may see fit to grant, excepting, however, such Honorary Members as may be elected from *active membership*, when they shall retain their right to vote and to hold office.

ASSOCIATE MEMBERS.

SEC. 4.—Any person desiring to become associated with this Society, who is not eligible to active membership, may make application, and if said application receives a favorable report from the Board of Direction, it shall be acted upon by the Society at the next regular meeting, and if said candidate shall receive a majority of the votes cast he shall be declared elected as an Associate Member. Associate Members shall have no vote, nor shall they be eligible for any office.

ARTICLE III

OFFICERS AND THEIR DUTIES

OFFICERS

Section 1. The officers of the Society shall be a President, two Vice Presidents, a Secretary and Treasurer, an Assistant Secretary, and four Directors.

ELECTION OF OFFICERS

Sec. 2. [illegible] excepting the Assistant Secretary, shall be elected [illegible] shall [illegible] their respective offices until the [illegible] meeting [illegible] others are elected and qualified [illegible]

[illegible]

Sec. 3. [illegible] meeting when present. He [illegible] all standing committees [illegible] unless otherwise ordered [illegible]

[illegible]

Sec. 4. [illegible] the Sec- [illegible]

Sec. 5. [illegible] Society and the [illegible] shall [illegible] communications [illegible] committees [illegible]

Sec. 6. [illegible] the funds [illegible] the Society [illegible] shall [illegible]

ASSISTANT SECRETARY.

SEC. 7.—The Assistant Secretary shall be appointed annually by the President, and his duties shall be such as would pertain to the office of executive secretary.

BOARD OF DIRECTION.

SEC. 8.—This Board shall consist of the President, the two Vice Presidents, and the four Directors. It shall have supervision and care of all the affairs and property of the Society, and shall conduct the same in accordance with the Constitution and By-Laws. The President or one of the Vice Presidents shall preside at all meetings of the Board, in the order of seniority. In the absence of all these officers, a chairman *pro tem.* may be appointed for the meeting. The first year after this section is adopted, four members shall be chosen at the annual meeting, two shall be chosen for a term of one year and two to serve two years. At all subsequent annual meetings two members shall be chosen to serve two years. Four members shall constitute a quorum to transact business.

ARTICLE IV.

ELECTIONS.

OFFICERS, WHEN ELECTED.

SECTION 1.—At each annual meeting the Society shall elect by ballot, a President, two Vice Presidents, and a Secretary and Treasurer, to serve one year; also two Directors to serve two years.

NOMINATIONS, HOW MADE.

SEC. 2.—A nominating blank, containing a list of officers to be voted for, shall be sent by the Secretary to each member, at least sixty (60) days before the day of the annual meeting. The nominations for officers shall be returned to the Secretary in an envelope endorsed with the member's signature, within twenty-one (21) days from the date upon which the blanks were mailed to members, and shall be delivered by him, unopened, to the Board of Direction at a meeting to be held by them to canvass such nominations.

A member nominated for an office by as many as ten (10) other menbers may become a candidate for that office. If a member be nominated for more than one office, he shall be considered as having been nominated for that office for which he received the most nominating ballots.

If no member receives ten (10) nominating ballots for an office, or if for any reason there should be no candidate for an office, the Board of Direction shall nominate at least two candidates for that office.

All nominees for office shall be notified at once by the Secretary of their nomination and, unless the Secretary receives a prompt declination, it shall be assumed that they have accepted such nomination.

ELECTIONS, HOW CONDUCTED

SEC. 3.—At least twenty-one (21) days before the annual meeting the Secretary shall send each member a ballot containing the names (arranged alphabetically) of the candidates for each office. This shall be accompanied by an envelope addressed to the Secretary, with a blank space on the back for the signature of the member voting, also a blank envelope carrying no mark for recognition.

Each member shall signify his choice of candidates on the ballot and return it to the Secretary in two sealed envelopes; the inner one to be left entirely blank, and the outer one endorsed with signature of sender.

Ballots may be sent by mail to the Secretary or handed to him directly. The Secretary shall deliver the ballots unopened to the tellers appointed by the presiding officer.

The polls will close at eleven o'clock in the morning of the day of the regular annual business meeting of the Society.

MEMBERS IN ARREARS CANNOT VOTE.

SEC. 4.—It shall be the duty of the Treasurer to furnish the tellers with an alphabetical list of members in arrears for dues for two years or more, and no vote from a member so in arrears shall be counted. Ballots received from such members shall be returned to them unopened with a statement of the reason for such action.

PLURALITY ELECTS.

SEC. 5.—The candidate for each office receiving a plurality of the votes shall be declared elected. In case of a tie vote, the meeting shall proceed to vote by ballot for the candidates who are tied.

NOTIFICATION.

SEC. 6.—The Secretary shall officially notify in writing each officer of his election.

Officers so elected shall qualify and assume their duties immediately after the adjournment of the meeting at which they are elected, and shall hold office until their successors are duly elected and qualified.

VACANCIES.

SEC. 7.—Vacancies occurring for any cause in the list of officers shall be filled by the Board of Directors.

ELECTION OF MEMBERS.

SEC. 8.—Each application shall be announced in the notices for the next meeting after it is received, and shall then be considered by the Board of Directors, and if approved shall be presented to the Society for ballot at a regular meeting. If the candidate receives a majority of the ballots, he shall be declared elected. In case of rejection, no minute shall be published, but the Secretary shall notify the applicant by letter.

APPLICATION FOR MEMBERSHIP.

SEC. 9.—All applications for membership or for transfer from one grade of membership to another, shall be made on a regular form, to be secured from the Secretary, and to be endorsed by three Members. This form shall contain, immediately over the signature of the applicant, a clause in which the applicant shall agree that if elected he will be governed in all Society matters by the Constitution and By-Laws, and will forward the interests of the Society at all times.

ARTICLE V.

MEETINGS.

ANNUAL MEETING.

SECTION 1.—There shall be a *regular annual meeting* held on the second Tuesday of February each year, at such place as may be selected by the Board of Direction, of which due notice shall be given by the Secretary.

MEETINGS, HOW CALLED.

SEC. 2.—Special meetings may be called by the President and, when so called, notice of the meeting specifying the business thereof shall be mailed by the Secretary to the postoffice address of each member at least ten days before such meeting shall be held. Special meetings shall be called by the President on written application of any ten (10) members.

QUORUM.

SEC. 3.—Ten per cent. of the membership shall constitute a quorum for the transaction of ordinary business, except for the election of officers or for voting on amendments to the Constitution or By-Laws, which shall require fifteen per cent.

ARTICLE VI.

DUES.

SECTION 1.—The annual dues of Members and Associate Members shall be three ($3.00) dollars per year, payable in advance at the annual meeting.

Members elected at any time of the year shall pay full dues for that year.

SEC. 2.—Honorary Members shall pay no annual dues.

SEC. 3.—The Board of Direction shall have power to remit dues when, in their opinion, it is for the best interest of the Society.

ARTICLE VII.

DEPRIVATION OF MEMBERSHIP.

SECTION 1.—Any member whose dues shall remain unpaid for two (2) years shall be notified by the Treasurer, by sending by registered mail a bill for dues in arrears, on the face of which bill shall be printed the sections of the Constitution covering such cases. If the dues are not paid within thirty (30) days after such notification, the matter shall be presented to the Board of Directors, who shall have power to drop such member from the roll.

RESIGNATIONS

SEC. [illegible]. Resignations must be submitted in writing to the Secretary and may be accepted by the Board of Directors when all indebtedness to the Society has been discharged.

SEC. [illegible]. All charges against any member shall be investigated by the Board of Directors before being submitted to the Society.

Any member may be expelled for conduct which may be deemed prejudicial to the Society by a two-thirds vote of the Members present at a business meeting, provided that not less than fifteen (15) vote for expulsion, and that such member shall have had one month's notice of the charges preferred against him and of the time appointed for their consideration [illegible] the offense or offenses [illegible] members preferring them. [illegible] shall be entitled to be [illegible] at all meetings [illegible] during the time when [illegible]

[illegible]

[illegible] must be presented [illegible] Society and signed [illegible]

[illegible] meeting and a copy [illegible] the vote presented [illegible]

[illegible]

BY-LAWS.

MEETINGS.

1. In addition to the regular annual meeting, as provided by the Constitution, the Society shall hold at least one other general meeting, and may hold such other meetings to listen to lectures or addresses, or to visit engineering works of interest, or of a purely social nature, as the Board of Direction may decide to call.

GENERAL ORDER OF BUSINESS AT ANNUAL MEETING.

2. The following general order of business shall be observed at annual meetings:

1. Presentation of, and action upon, minutes of last meeting.
2. Report of Board of Direction.
3. Report of Secretary.
4. Report of Treasurer.
5. Report of any Special Committees.
6. Election of new members.
7. Election of officers.
8. Address of President.
9. Miscellaneous business.
10. Papers, lectures, or addresses.
11. Adjournment.

BUSINESS MEETINGS—ORDER.

3. The following general order shall be observed at Business Meetings:

1. Presentation of, and action upon, minutes of last meeting.
2. Miscellaneous announcements.
3. Stated business.
4. Adjournment.

4. Contributing Members under the old Constitution shall become Associate Members upon the adoption of the Revised Constitution.

5. Actual personal transportation expenses incurred by the Secretary in attending meetings shall be paid from the Society treasury, upon approval of the President or two members of the Board of Direction

6. In the election of Honorary Members, a unanimous vote is necessary to elect.

7. The Society may at any time, duly named for the purpose, enact By-Laws for the future guidance, consonant with the Constitution. These By-Laws may be amended or repealed at any meeting, in the call for which meeting a copy of the proposed amendment or addition shall have been printed and sent to each member with the said notice.

PARLIAMENTARY RULES

8. In all questions arising at any meeting, involving parliamentary rules, not provided for in these By-Laws, Roberts' Rules of Order shall be the governing authority.

VISITORS

9. Visitors may be admitted to meetings under such rules as the meeting may prescribe.

10. All forms such as blanks for application for membership, ballots for officers, ballots on amendments to Constitution or By-Laws, and other necessary blanks for the conduct of the business of the Society, shall be prepared by the Secretary and approved by the Board of Directors.

List of Members.

With Addresses and Dates of Election.

Members are particularly requested to inform the Secretary at once of any change in address.

HONORARY MEMBBRS.

PROF. RUSSELL H. CHITTENDEN............................April 20, 1901
Dean of Sheffield Scientific School of Yale University, New Haven, Conn.

EDGAR CLARK..June, 1887
Putnam, Conn.

JOHN E. CLARK..April, 1884
Prof. Mathematics, Emeritus, at Sheffield Scientific School, Yale University,
South Terrace, Longmeadow, Mass.

DESMOND FITZGERALD...Jan. 8, 1901
Engineer Sudbury Division, Metropolitan Water Board,
1 Ashburton Place, Boston, Mass.

GEORGE H. FROST...April, 1884
President Engineering News Publishing Co., New York.

DR. ARTHUR T. HADLEY.....................................April 20, 1901
President Yale University, New Haven, Conn.

EDWARD C. HAYNES..Jan. 14, 1890
Nashua, N. H.

BRADLEY H. HULL...April, 1884
Bridgeport, Conn.

WILLIAM E. PETTEE..Jan. 10, 1899
Civil Engineer, Salisbury, Conn.

WILLIAM O. SEYMOUR..Feb. 9, 1904
Railroad Commissioner, Ridgefield, Conn.

FRANK W. SKINNER..Jan. 9, 1900
Editorial Staff of the Engineering Record, New York.

MEMBERS.

ARTHUR A. ADAMS...Jan. 9, 1900
Superintendent of Streets, Springfield, Mass.

JULIUS L. ADAMS..July 18, 1899
Civil Engineer Hartford, Manchester and Rockville Tramway Co.,
South Manchester, Conn.

ALGERNON B. ALDERSON...................................Jan. 10, 1899
Town Engineer, West Hartford, Conn.

WALTER H. ALLEN...Feb. 11, 1902
U. S. Engineer Brooklyn Navy Yard, New York.

GUSTAVE X. AMRHYN...Feb. 9, 1904
Associate Member, New Haven, Conn.

HARLES BUSCHOR..........Jan. 10, 1899
Civil Engineer and Surveyor, Central Valley, New York.

M H. CADWELL..........May 31, 1893
Civil Engineer, New Britain, Conn.

NDER CAHN..........Jan. 9, 1900
Civil Engineer, New Haven, Conn.

A. CAIRNS..........Aug. 29, 1890
nitary and Hydraulic Engineer and City Engineer, Waterbury, Conn.

D. CARD..........Oct. 24, 1895
Civil Engineer and Surveyor, Willimantic, Conn.

E. CARLISLE..........Jan. 9, 1900
S. N. E. Telephone Co., New Haven, Conn.

B. CARTER..........Jan. 14, 1890
Civil Engineer, 26 Courtlandt St., New York.

CAUM..........Aug. 14, 1900
Superintendent Hartford Street Railway, Hartford, Conn.

S E. CHANDLER..........April, 1884
Civil Engineer, Norwich, Conn.

ICK S. CHAPMAN..........Feb. 10, 1903
Philippine Islands.

S F. CHASE..........March 30, 1900
Engineer Berlin Construction Co., New Britain, Conn.

D OTIS CHENEY, JR...........Jan. 9, 1900
Civil Engineer, South Manchester, Conn.

T G. CLARK..........July 18, 1899
Engineer of Keney Park, Hartford, Conn.

N. CLARK..........July 18, 1899
Civil Engineer Department of Public Parks, Hartford, Conn.

T B. CLARK..........Feb. 9, 1904
Civil Engineer, Milford, Conn.

M S. CLARK..........July 14, 1890
City Engineer, Meriden, Conn.

M B. COCHRANE..........Jan. 14, 1890
Civil Engineer, Stamford, Conn.

RE I. COE..........Jan. 9, 1900
Superintendent of Construction, 454 Fifth Ave., New York.

COGGESHALL..........June, 1887
Superintendent of Water Works, New Bedford, Mass.

N L. COLE..........Feb. 9, 1904
Civil Engineer, Hartford, Conn.

C. COLLINS..........July 18, 1899
Berlin Construction Co., Boston, Mass.

M R. C. CORSON..........Feb. 10, 1903
Civil Engineer, Hartford, Conn.

K. CRANDALL..........Jan. 11, 1887
City Engineer, New London, Conn.

S M. CRAWFORD..........July 18, 1899
Secretary Hartford Paving and Construction Co., Hartford, Conn.

McDONALD CRAWFORD..........July 18, 1899
General Manager Hartford Street Railway Co., Hartford, Conn.

E S. CURTIS..........Jan. 9, 1900
Vice President N. Y., N. H. & H. R. R., Boston, Mass.

THEODORE ALLEN CURTIS .... Aug. 24, 1905
Curtis & Johnson, Hartford, Conn.

LOREN E. DABOLL .... Jan. 6, 1895
Civil Engineer, New London, Conn.

COURTLAND R. DARROW .... Jan. 6, 1895
Civil Engineer, New London, Conn.

ARTHUR R. DAVIS .... July 18, 1899
Assistant Manager Eastern District and Export, American Bridge Co.,
66 Broadway, New York.

[illegible] DAVIS .... Oct. [illegible], 19[illegible]
Architect, Hartford, Conn.

FREDERICK [illegible] DEMPSTER .... Sept. 5, 1891
[illegible] Trap Rock Co., Meriden, Conn.

[illegible] .... Jan. 6, 19[illegible]
Chief Engineer, New York Rapid Transit Subway Construction Co.,
New York City, N. Y.

[illegible] .... Jan. 6, 19[illegible]
[illegible] Civil Engineering, Sheffield Scientific School, Yale University,
New Haven, Conn.

[illegible] .... March 31, 19[illegible]
Assistant Engineer, N. Y., N. H. & H. R. R. Co., New Haven, Conn.

[illegible] .... Feb. [illegible], 19[illegible]
[illegible], Conn.

[illegible] .... Jan. 2, 19[illegible]
[illegible] Engineer, [illegible], Conn.

[illegible] .... March 31, 19[illegible]
[illegible] N. Y., N. H. & H. R. R. Co., New Haven, Conn.

[illegible] .... [illegible]
[illegible] New Haven, Conn.

[illegible] .... Feb. 2, 19[illegible]
[illegible], Conn.

[illegible] .... Jan. 2, 19[illegible]
[illegible] New Haven, Conn.

[illegible] .... April 21, 19[illegible]
[illegible] New Haven, Conn.

[illegible] .... Jan. [illegible]
[illegible]

[illegible] .... April 21, 19[illegible]
[illegible]

[illegible] .... Feb. 11, 19[illegible]
[illegible] New Haven, Conn.

[illegible] .... Jan. 5, 19[illegible]
[illegible] New Haven, Conn.

[illegible] .... Jan. 2, 19[illegible]
[illegible] West Haven, Conn.

[illegible] .... Jan. [illegible], 1890
[illegible]

[illegible] .... Jan. 2, 1900
[illegible] New Haven, Conn.

[illegible] .... Jan. 2, 1900
Assistant City Engineer, New Haven, Conn.

[illegible] GROSS .... Nov. 28, 1899
Assistant Treasurer, [illegible] Waterbury, Conn.

N D. GRAVES..Oct. 25, 1895
Chief Engineer Conn. River Bridge and Highway District,
Hartford, Conn.

RT H. GREENWOOD..Feb. 9, 1904
Civil Engineer, Greenwood, Mass.

Y T. W. HALE..Feb. 10, 1903
Civil Engineer, Portland, Conn.

ARK HALL..Jan. 8, 1901
Hartford Water Department, West Hartford, Conn.

ISON C. HAMILTON..Jan. 9, 1900
With N. Y., N. H. & H. R. R. Co., Hartford, Conn.

HARTE..Feb. 9, 1904
Civil Engineer, Hartford, Conn.

HASTINGS, Associate Member..Feb. 10, 1903
B. D. Peirce Co., Bridgeport, Conn.

AMIN F. HATHAWAY..Aug. 14, 1900
Stamford, Conn.

UR S. HAWLEY..Feb. 11, 1902
C. W. Blakeslee & Co., New Haven, Conn.

S R. HAZELTINE..Feb. 11, 1902
Architect, 94 State St., New London, Conn.

HEFT..Jan. 8, 1901
Bridgeport, Conn.

AN C. HEITMAN, JR..Feb. 10, 1903
Civil Engineer, West Haven, Conn.

T. HENDERSON..July 18, 1899
Draftsman Conn. River Bridge and Highway District, Hartford, Conn.

RT B. HILL..Jan. 9, 1900
Civil and Consulting Engineer, New Haven, Conn.

K E. HINE..April 20, 1901
Fisher's Island, N. Y.

K N. HOYT..July 18, 1899
Civil Engineer Highway Commissioner's Office, Hartford, Conn.

EL N. HOYT, JR..Feb. 9, 1904
Civil Engineer, South Norwalk, Conn.

INGERSOLL, JR..Jan. 8, 1901
Chief Engineer N. Y., N. H. & H. R. R., New Haven, Conn.

ARD R. INGRAHAM..Feb. 9, 1904
Civil Engineer, Hartford, Conn.

EDERICK JACKSON..Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

R S. JAMESON..Feb. 9, 1904
Civil Engineer, Bridgeport, Conn.

LES M. JARVIS..*April, 1884
Vice President P. & F. Corbin Co., New Britain, Conn.

K B. JAYNES..Feb. 10, 1903
Civil Engineer, Bridgeport, Conn.

C. JESSUP, JR..Feb. 9, 1904
Civil Engineer, South Norwalk, Conn.

IAM D. JOHNSON..Aug 14, 1900
Architect, 926 Main St., Hartford, Conn.

IAM E. JOHNSON..Nov. 29, 1890
Engineer of Hartford Water Works, West Hartford, Conn.

EDWIN [illegible] JONES . . . . Feb. 6, [illegible]
Civil Engineer, Hartford, Conn.

WALTER A. JONES . . . . Feb. [illegible]
Civil Engineer, New Haven, Conn.

HERBERT C. KEITH . . . . Jan. 9, [illegible]
Chief Engineer MacArthur Bros. Co., New York City

HENRY [illegible] KELLOGG . . . . April, [illegible]
First Assistant City Engineer, New Haven, Conn.

CASSIUS W. KELLY . . . . Jan. 6, [illegible]
City Engineer, New Haven, Conn.

RICHARD S. KIRBY . . . . March 30, [illegible]
Civil Engineer, Port Chester, N. Y.

[illegible] . . . . Jan. [illegible]
With Hartford Street Railway Co., Hartford, Conn.

HERBERT A. KNIGHT . . . . Jan. [illegible]
[illegible] Connecticut Company [illegible]
[illegible], Conn.

[illegible] . . . . Jan. [illegible]
[illegible] N. Y.

[illegible] . . . . Jan. [illegible]
[illegible] Meriden, Conn.

[illegible] . . . . Jan. [illegible]
[illegible] Mass.

[illegible] . . . . Feb. [illegible]
Civil Engineer, Bridgeport, Conn.

[illegible] . . . . March 31, [illegible]
[illegible] Hartford, Conn.

[illegible] . . . . Jan. [illegible]
[illegible] Leavenworth, Kansas.

[illegible] . . . . Feb. [illegible]
[illegible] Mass.

[illegible]
[illegible] Conn.

[illegible]
[illegible] Conn.

[illegible]
[illegible] Conn.

[illegible]
[illegible]

[illegible] . . . . April [illegible]
[illegible] New Haven, Conn.

[illegible] . . . . Jan. [illegible]
[illegible]

[illegible]
[illegible]

[illegible] . . . . April, [illegible]
[illegible] Conn.

[illegible] . . . . April, [illegible]
[illegible]

[illegible] . . . . May [illegible]
[illegible] Conn.

[illegible] . . . . Feb. [illegible]
[illegible]

CHARLES W. MERRELS..Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

GEORGE S. MILLER..Aug. 22, 1901
Civil Engineer U. S. Fortification, Fisher's Island, N. Y.

EDWARD E. MINOR..Feb. 9, 1904
Civil Engineer, New Haven, Conn.

SHELDON E. MINOR..Sept. 25, 1886
Civil Engineer, Greenwich, Conn.

ROBERT E. MITCHELL..Jan. 9, 1900
Civil Engineer and Surveyor, Willimantic, Conn.

WM. HARLEY MOORE..Jan. 9, 1900
Engineer Bridges, N. Y., N. H. & H. R. R., New Haven, Conn.

ERNEST B. MOSS..April 20, 1901
Civil Engineer, H. Wales Lines Co., Meriden, Conn.

HAROLD T. MURPHY..Feb. 9, 1904
Civil Engineer, Springfield, Mass.

JOHN P. MURPHY..July 18, 1899
City Engineer's Office, Hartford, Conn.

PAUL NASH..Jan. 9, 1900
City Engineer and Surveyor, Stamford, Conn.

CHARLES H. NICHOLS..Jan. 8, 1901
Consulting Engineer and Engineer of Shell Fish Commission,
New Haven, Conn.

CLARENCE H. NICHOLS..Feb. 9, 1904
Civil Engineer, Danielson, Conn.

EDWARD J. NOBLE..Jan. 8, 1901
Hartford, Conn.

JOHN O'CONNOR, Associate Member..Feb. 9, 1904
Hartford, Conn.

FRANCIS H. OLDERSHAW..Jan. 8, 1901
City Engineer, New Britain, Conn.

C. HENRY OLMSTED..July 18, 1899
Civil Engineer and Surveyor, East Hartford, Conn.

FRED. H. OSBORNE..Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

ELIJAH H. OWEN..March 30, 1900
Civil Engineer, Hartford, Conn.

SHEPARD B. PALMER..Jan. 8, 1895
Civil Engineer and Surveyor, Norwich, Conn.

GEORGE E. PALMER..March 30, 1900
Assistant Engineer N. Y., N. H. & H. R. R., West Haven, Conn.

WILLIAM B. PALMER..Jan. 13, 1885
Civil Engineer and Surveyor, Bridgeport, Conn.

GEORGE A. PARKER..July 18, 1899
Superintendent of Keney Park, Hartford, Conn.

FRED H. PARSONS..Oct. 11, 1902
Sup't Mulloy, Rexford & Co., Williamsbridge, N. Y.

HAROLD A. PARSONS..Aug. 14, 1900
City Engineer, Stamford, Conn.

ARTHUR J. PATTON..Sept. 12, 1889
Land Surveyor, Waterbury, Conn.

ERMON M. PECK..Jan. 8, 1895
Assistant Engineer Hartford Water Works, West Hartford, Conn.

LEON F. PECK ....Oct. 11, 1902
Civil Engineer, Greenwich, Conn.

GEORGE W. PENFIELD ....Jan. 8, 1901
52 Camp St., New Britain, Conn.

JAMES W. PHELPS ....Oct. 11, 1902
Civil Engineer, Hartford, Conn.

WILLIAM B. PIERCE ....Feb. 9, 1904
Civil Engineer, Stamford, Conn.

STEPHEN C. PIERSON ....Jan. 13, 1885
Civil Engineer and Surveyor, Meriden, Conn.

ROBERT G. PIKE ....Jan. 8, 1901
Sewer Commissioner, Middletown, Conn.

WILLIAM K. PIKE ....Feb. 9, 1904
Civil Engineer, Danielson, Conn.

[illegible] ....Jan. 8, 1901
Civil Engineer, [illegible], Mass.

[illegible] ....Feb. 10, 1903
Civil Engineer, New London, Conn.

[illegible] ....Jan. 6, 1900
[illegible] R. R. Co., New Haven, Conn.

[illegible] ....Aug. [illegible]
[illegible]

[illegible] ....April [illegible] 1882
[illegible]

[illegible] ....March [illegible]
[illegible] Conn.

[illegible] ....Jan. [illegible] 1898
[illegible] Mass.

[illegible] ....Feb. [illegible]
[illegible]

[illegible] ....Jan. [illegible]
[illegible] Conn.

[illegible] ....Jan. [illegible]
[illegible]

[illegible] ....Jan. [illegible]
[illegible]

[illegible] ....Jan. [illegible]
[illegible]

[illegible] ....Feb. [illegible]
[illegible]

[illegible] ....Feb. [illegible]
[illegible]

[illegible] ....[illegible]

[illegible] ....March [illegible]

[illegible] ....[illegible]
[illegible]

[illegible] ....Jan. [illegible]
[illegible]

[illegible] ....Jan. [illegible]
[illegible]

HENRY SOUTHER........................Jan. 10, 1899
Consulting Engineer, Hartford, Conn.

NORMAN C. SPENCER........................Jan. 8, 1901
Civil Engineer, Hartford, Conn.

WALTER T. SPENCER........................Jan. 9, 1900
Division Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

A. WILLIAM SPERRY........................Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

HARTLEY W. SPERRY........................Feb. 9, 1904
Associate Member, Old Saybrook, Conn.

ELMER W. STEARNS........................Oct. 11, 1902
Civil Engineer, Berlin, Conn.

EDGAR H. STILES........................Oct. 11, 1902
Superintendent Lathrop, Shea & Henwood Co., New Haven, Conn.

PAUL STIRLING........................Oct. 11, 1902
American Tube & Stamping Co., Bridgeport, Conn.

RAYMOND FRENCH STODDARD........................Jan. 9, 1900
Civil Engineer with N. Y., N. H. & H. R. R., Bridgeport, Conn.

EDWARD M. STONE........................July 18, 1899
With H. A. Wolcott, Hartford, Conn.

HARRY A. STORRS........................July 18, 1899
U. S. Reclamation Service, Denver, Col.

LUCIAN A. TAYLOR........................June, 1887
Civil Engineer and Contractor, Boston, Mass.

WILLIAM T. TAYLOR........................Feb. 9, 1904
Civil Engineer, Hartford, Conn.

ALFRED H. TERRY........................Feb. 11, 1900
Engineering Department, N. Y., N. H. & H. R. R. Co.,
New Haven, Conn.

JAMES B. THOMAS........................Jan. 9, 1900
Civil Engineer and Surveyor, Hartford, Conn.

JOHN C. TRACY........................Jan. 9, 1900
Assistant Professor of Structural Engineering, Yale University,
New Haven, Conn.

WALTER E. TRUESDELL........................June 11, 1898
With Joseph H. Wallace, C.E., New York City.

MAX J. UNKELBACH........................Jan. 9, 1900
With W. H. Cadwell, New Britain, Conn.

GEORGE E. VERRILL........................Feb. 11, 1902
U. S. Assistant Engineer, New Haven, Conn.

CLARENCE B. VORCE........................Jan. 10, 1899
John F. Kelly Engineering Co., New York City.

JOSEPH P. WADHAMS........................Feb. 9, 1904
Civil Engineer, Torrington, Conn.

A. R. WADSWORTH........................Oct. 27, 1886
Civil Engineer and Surveyor, Farmington, Conn.

EDWARD T. WARD........................Jan. 9, 1900
Consulting Engineer, Bridgeport, Conn.

FREDERICK S. WARDWELL........................Feb. 9, 1904
Civil Engineer, Stamford, Conn.

ALBERT L. WASHBURN........................Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

HALSEY A. WEAVER ....Jan. 12, 1897
Civil Engineer, Clinton, Conn.

NELSON J. WELTON ....April, 1884
Civil and Hydraulic Engineer, Waterbury, Conn.

MARION H. WEST ....Feb. 9, 1904
Civil Engineer, Hartford, Conn.

CHAS. A. WHEELER ....Jan. 8, 1901
Prof. of Mathematics, Conn. Agricultural College, Storrs, Conn.

FREDERICK J. WHEELER ....Aug. 27, 1901
U. S. Engineer's Office, New London, Conn.

HOWARD E. WHITE ....Feb. 9, 1904
Civil Engineer, New Haven, Conn.

ELI WHITNEY ....March 30, 1900
President, New Haven Water Co., New Haven, Conn.

GEORGE E. WHITNEY ....March 30, 1900
Superintendent Stamford Water Co., Stamford, Conn.

JAMES W. WILSON ....March 30, 1900
Second Assistant Bridge Engineer, N. Y., N. H. & H. R. R.,
New Haven, Conn.

[illegible] W. [illegible] ....Jan. 8, 1901
Civil Engineer, Middletown, Conn.

[illegible] ....April, 1884
Civil Engineer, New Rochelle, New York.

[illegible] ....July 15, 1899
[illegible] New London, Conn.

[illegible] ....July 15, 1899
[illegible] Engineer, Hartford, Conn.

[illegible] ....Aug. [illegible]
[illegible]

[illegible] ....Jan. [illegible]
[illegible] Conn.

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[illegible]

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[illegible] FREDERICK L. FORD

City Engineer

[illegible]

[illegible]

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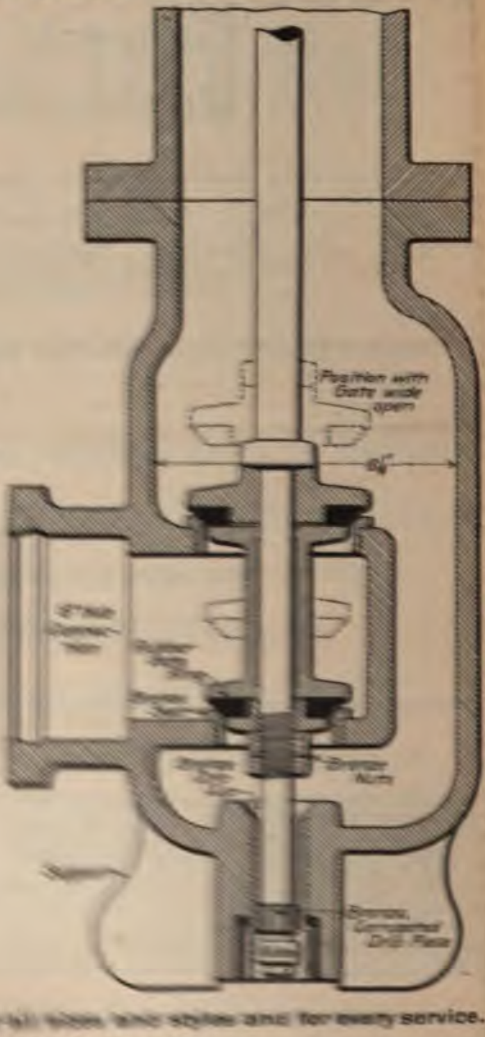

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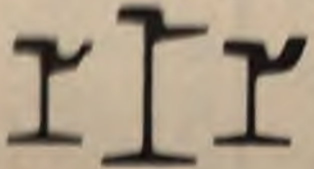

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In 1900.	Grand Av., bet. the Mill and Quinnipiac Rivers,	22,697.2	"	"	
In 1900.	Commerce St., bet. Cong. Av. and Whiting St.,	2,708.5	"	"	
In 1901.	Chapel St., bet. York and State Sts.,	13,491.8	"	"	
In 1901.	Congress Av., bet. George and Temple Sts.,	4,206.0	"	"	Grout Joints
In 1901.	Crown St., bet. State and Temple Sts.,	3,567.8	"	"	
In 1901.	Elm St., bet. State and York Sts.,	13,377.2	"	"	
In 1901.	George St., bet. State and Temple Sts.,	5,661.2	"	"	
In 1901.	Temple St., bet. Elm St. and Congress Av.,	7,480.0	"	"	
In 1902.	Olive St., bet. State and Water Sts.,	10,341.0	"	"	
	Total - - - - - - -	87,543.7	"	"	

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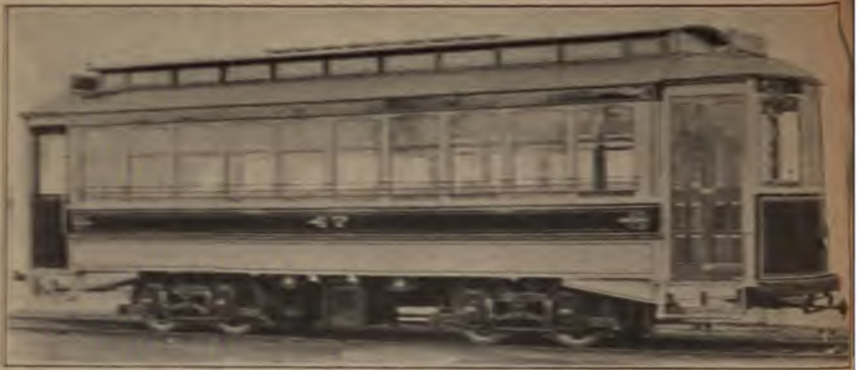

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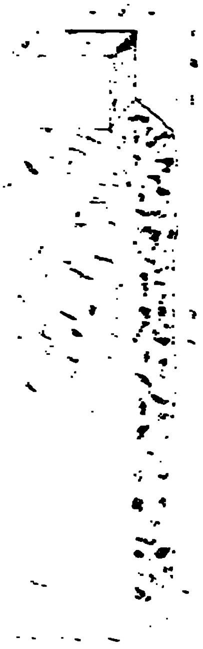

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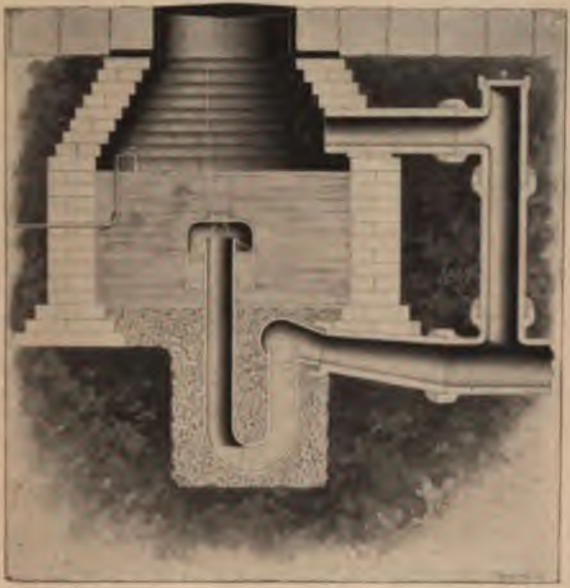

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Society of Civil Engineers

Papers and Transactions for 1905

AND

Proceedings

OF THE

Twenty-first Annual Meeting

AT

NEW HAVEN, FEBRUARY 14 and 15, 1905

New Haven
THE TUTTLE, MOREHOUSE & TAYLOR COMPANY
1905

Connecticut Society of Civil Engineers

ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884

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NEW HAVEN FILTRATION PLANT.

By Charles A. Ferry.

The New Haven Water Company, which supplies water to New Haven, West Haven and portions of East Haven and Hamden, obtains its supply from six different sources: Lake Whitney, an impounding reservoir on Mill river, at Whitneyville, with a watershed of 37.7 square miles and an available storage capacity of about 170 million gallons. (The storage capacity of this lake is much larger than this, but, by agreement with the town of Hamden, it can only be drawn down 4 feet, making the available storage relatively small.) Lake Saltonstall, a natural lake with an area of about 420 acres, the surface of which can be drawn down 9 feet, affording a reserve supply of about 1,200 million gallons. This lake has a watershed of 4 square miles. Woodbridge, with three impounding reservoirs, with a combined storage of 975 million gallons and with a watershed of 13.6 square miles; Wintergreen, an artificial lake on the easterly slope of West Rock ridge, with a storage of 100 million gallons and a watershed of 1.1 square miles; Maltby lakes, three small impounding reservoirs, with a total storage of 185 million gallons and a watershed of 1.3 square miles, and Lake Phipps, a small impounding reservoir, with a storage of about 70 million gallons and a watershed of 0.4 square miles. This last supply is supplemented by a pumping station on a small stream, the outlet of Wards pond, with a watershed of 1.6 square miles.

The Lake Phipps supply was acquired by the New Haven Company by the purchase of the West Haven Company, and was formerly used for supplying West Haven, but the elevation of the reservoir is so low, only about 65 feet above sea level, that it has been abandoned for general use since coming into the possession of the New Haven Company, that borough now being supplied from Maltby lakes; the Lake Phipps supply being held in reserve in case of some accident which would necessitate the temporary shutting off of the Maltby supply.

Of the other five supplies mentioned, the water from Lakes Whitney and Saltonstall are pumped to distribution reservoirs; the other three being gravity supplies. Of the latter, Lake Wintergreen, at an elevation of about 240 feet above sea level, is used mainly as a high service system, supplying the Almshouse and the Prospect hill district.

The reservoirs of the four supplies, Whitney, Saltonstall, Woodbridge and Maltby, are at such elevations that it is not necessary to separate the different systems or insert regulating devices in the distribution mains, but they are all connected together. All of the water which the gravity supplies can furnish or deliver is drawn and the deficiency met by pumping from the low level supplies. Of these, Saltonstall can furnish from 3 to 4 million gallons per day, and, for the balance, from 5 to 10 million gallons per day, dependence must be placed upon Lake Whitney. It thus becomes imperative that nothing should happen which would for any considerable length of time, shut off the supply from this latter source.

The water company owns practically all of the land, with the exception of the highways, in the immediate vicinity of its reservoirs, and, for the Saltonstall, Woodbridge, Wintergreen and Maltby systems, a very large part of the entire watersheds. These last four mentioned sheds are also very sparsely settled; large portions of each being wooded, so that the danger of these supplies being contaminated is comparatively slight.

With Whitney lake, however, the case is different. The Mill river valley is, in large part, devoted to pasture or tilled land, and, with the small manufacturing hamlets at Cheshire, Mt. Carmel, Ivesville, Centerville and Augurville, supports quite a large population. To control this watershed by purchase was therefore impracticable.

All of the watersheds are daily patrolled by inspectors, in the employ of the company, who seek to discover and remove sources of possible contamination. All filth on the highways, in the vicinity of the reservoirs, is daily removed; leaves and rubbish along the margins of the lakes and streams is raked up and burned, and, in connection with the health officers of the different towns, all cases of sickness suspected of being of a typhoid nature or other water-borne disease, are carefully watched, and the premises where such cases occur are thoroughly disinfected.

e water company, being desirous that the water supplied should be the best obtainable, about three years ago caused

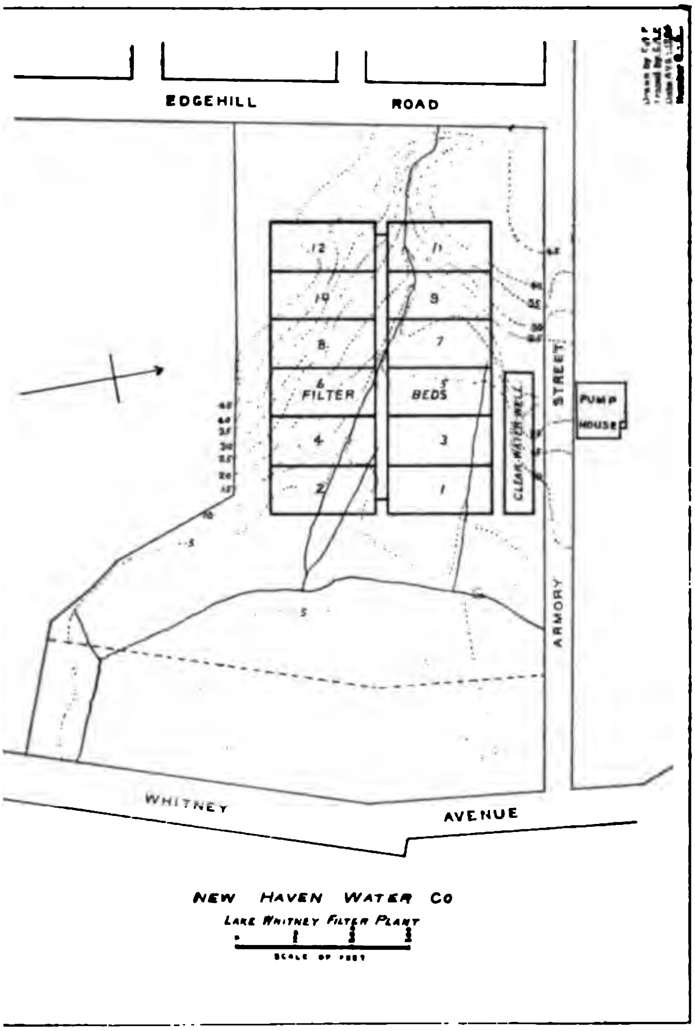


FIG. I. GENERAL PLAN OF FILTERS.

rough examination of all of its sources of supply to be by Mr. George W. Fuller of New York, a recognized rity on all matters relating to water purification. From xamination and a study of the series of tests of the different waters, which, for several years, had been made by Prof. H. E. Smith. Mr. Fuller recommended, in view of the liability of contamination of the Whitney supply and its vital importance to the company, that this water should be filtered.

The relative merits of sand and mechanical filters were carefully considered, and finally the method of slow sand filtration was adopted.

A tract of land of about 13 acres was purchased on the southerly side of Armory street opposite the steam pumping station, and the work of preparing it for the filters was immediately commenced.

While this was the best site available, it was by no means an ideal location, as about half of the area was a steep side hill and the remainder a swamp. The formation was very peculiar. A small ravine divided the upland into two nearly equal parts. On the northerly portion, beneath a layer of loamy gravel, was a bed of quicksand of unknown depth; the westerly part of the southerly portion was boulder hard pan, and the easterly part clean, sharp sand interlaid with thin strata of the quicksand.

The loam and muck was stripped from an area of about 5 acres, and then the ground was graded to a level about 15 feet below the level of Lake Whitney. The maximum cut was about 30 feet and the maximum fill about 18 feet.

The material was filled in in horizontal layers about 9 inches in thickness and rolled with a grooved roller. The different materials found in the cut, except the boulders, were mixed in making the fill, and, when combined, made excellent material for the purpose, as the fine quicksand filled the voids in the coarser material, making a foundation almost as hard and impervious to water as a clay puddle.

A portion of the ground was so soft and springy that it was necessary to underdrain it before a team could be driven over it.

After the grading had been practically completed, in the late fall of 1902, the area graded was enclosed by a low embankment and flooded with water from the springs in the hillside.

The next spring, the water was drained off, the grading completed and the whole area rolled with the grooved roller and a ten ton steam roller.

The plans for the filters, which are now being constructed, provide for twelve beds, each with a net sand surface of one-third of an acre. They are arranged in two groups of six beds each, on either side of a central administration building.

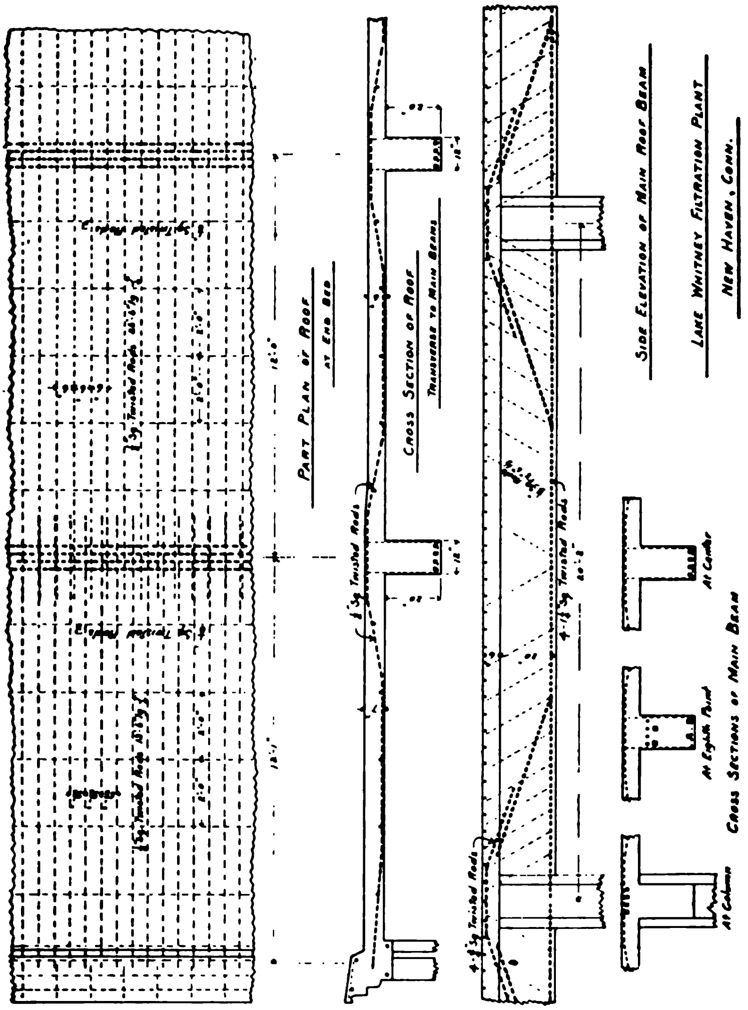

Part Plan of Roof at End Bed
Cross Section of Roof Transverse to Main Beams
Side Elevation of Main Roof Beam
Lake Whitney Filtration Plant
New Haven, Conn.
Cross Sections of Main Beam
At Column
At Eighth Point
At Center
Twisted Rods
12'-0"
10'-8"

FIG. 2. STEEL REINFORCEMENT IN ROOF.

Each bed is about 180 feet in length, 82½ feet in width, and about 15 feet in height, with the longitudinal axis at right angles to the central building.

The bottom of the beds is about 10 feet below the surrounding ground, and the ceiling, which is flat, about 5 feet

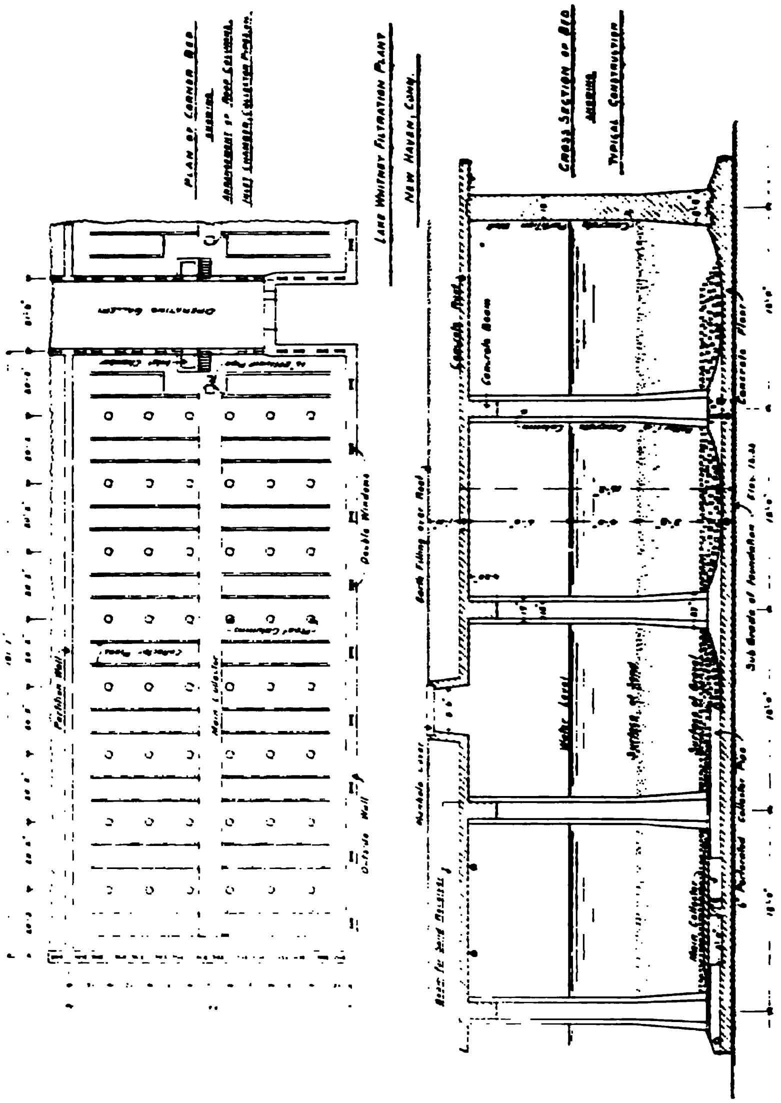


FIG. 3. PLAN AND SECTION OF ONE FILTER.

above. The outside wall, above the surface of the ground, is of brick, and is pierced with numerous windows, which, with a couple of ventilators in the roof and the windows opening into the operating gallery, will, under ordinary conditions, afford ample light and ventilation to the workmen when employed in cleaning the beds.

The outside windows are fitted with double sash window frames so that double windows can be used if found necessary to prevent the water on the beds from freezing.

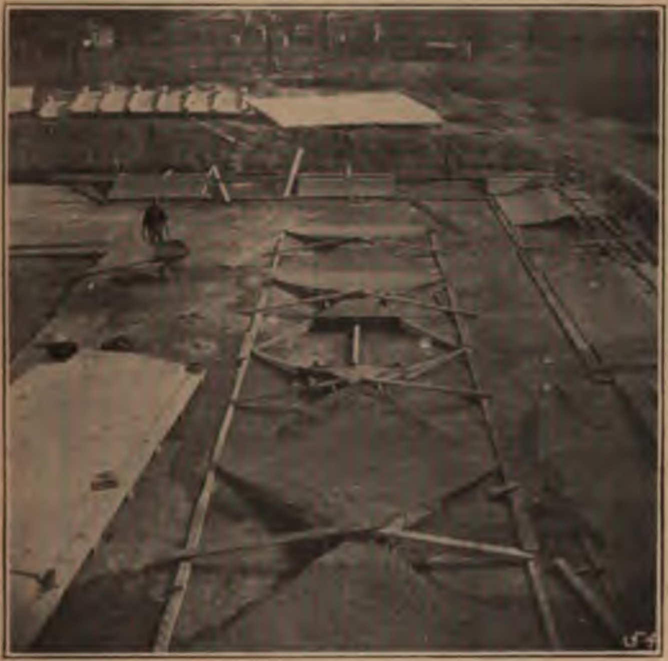


FIG. 4. BOTTOM OF FILTERS.

The roof is a flat slab of reinforced concrete supported by reinforced concrete beams resting on concrete columns. The roof is 6 inches in thickness, except the end panels, which are 7. The beams are 12 inches in width by 20 inches in depth, and are made in connection with the roof so as to have the benefit of the concrete in the roof acting in compression. The columns are eight sided; above the sand level they are 19 inches in width between parallel faces, the corners being truncated to leave a 12-inch face; below the sand level they widen to 27 inches in width. The tops of the columns are reinforced with a single hoop, 18 inches in diameter, of one-quarter of an inch square twisted iron.

The roof is to be covered with earth varying in depth from 24 inches at the sides of the central building to 20 inches at the opposite ends of the beds.

The bottom of the beds and the clear water well is made in two layers; the first course, 5 inches in thickness, is built in alternate blocks, each about 12 feet by 20 feet and 2 inches, and is reinforced by one-quarter-inch Ransome rods every 6 inches in both directions. The intermediate blocks are not built until the first set has set hard, at least twenty-four hours intervening betwen the building of the two sets.

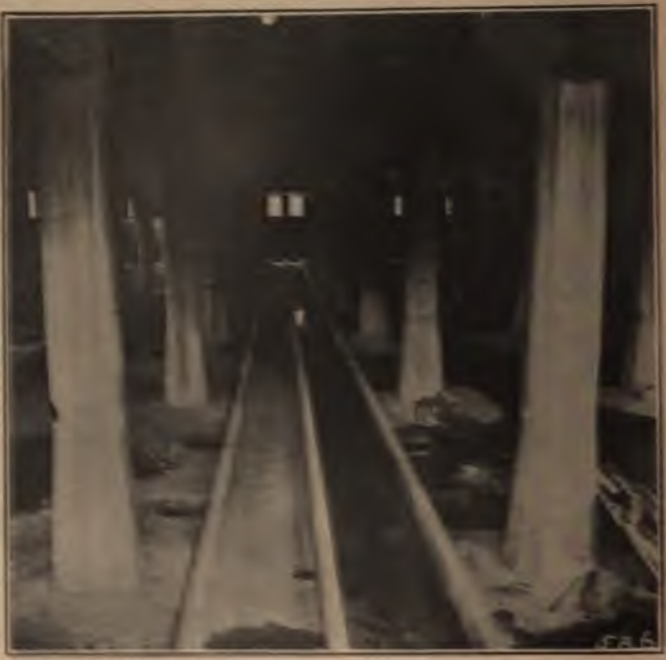


FIG. 5. INTERIOR OF FILTER, SHOWING WALLS OF COLLECTOR.

The second course is built in the form of inverted groined arches, varying in thickness from 3 to 13 inches, the high portions forming the bases for the columns and the walls. The joints of the second course breaking joints with those of the first course.

The surface of both of the bottom courses and the surface of the roof is floated, out of the concrete, with soft wooden floats and then troweled to a smooth surface.

The floor of each bed is divided into sixty-three sections by six rows of columns, 12 feet apart, running lengthways of the bed; there being eight columns, 20 feet and 2 inches apart in each row.

A double concrete collector, each part 3 feet wide and 10 inches high, covered by movable concrete slabs, runs longitudinally through the center of each bed and discharges through a cast iron outlet, 2 feet 6 inches by 3 feet built into the floor.

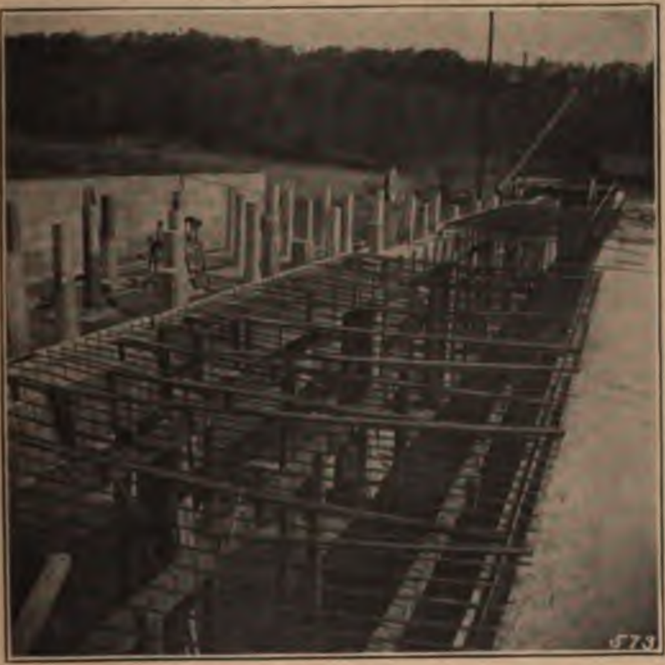


FIG. 6. STEEL IN ROOF SLAB.

Running transversely of the beds are two lines of 6-inch, perforated vitrified pipes in each bay; these discharge into the main collector just mentioned.

The bottom of the beds is to be covered, to a depth of 8 inches, with a layer of gravel or broken stone from 1 to 3 inches in diameter; on this will be placed successive layers of gravel and coarse sand, of gradually increasing degrees of fineness, until a total depth of 16 inches is obtained; on this will be placed the filter sand; this will be in the different beds, of depths varying from 2 feet to 3 feet 8 inches.

The steel reinforcement in the roof consists of four 1¼-inch Ransome rods in each beam, placed longitudinally, and twenty ¼-inch U shaped shear rods; in the roof slab there are ½-inch Ransome rods every 6 inches.

Two of the 1¼-inch beam rods run near the bottom of the beam for its entire length; the other two are near the bottom for about one-half the length of the beam at the center, then are bent upwards so that at the ends they are near the top. Over the columns there are four ¾-inch rods 7 feet long near the top of the slab. These are bent down at the ends to run alongside the bent 1¼-inch rods and splice with them, thereby making the beams practically continuous girders.

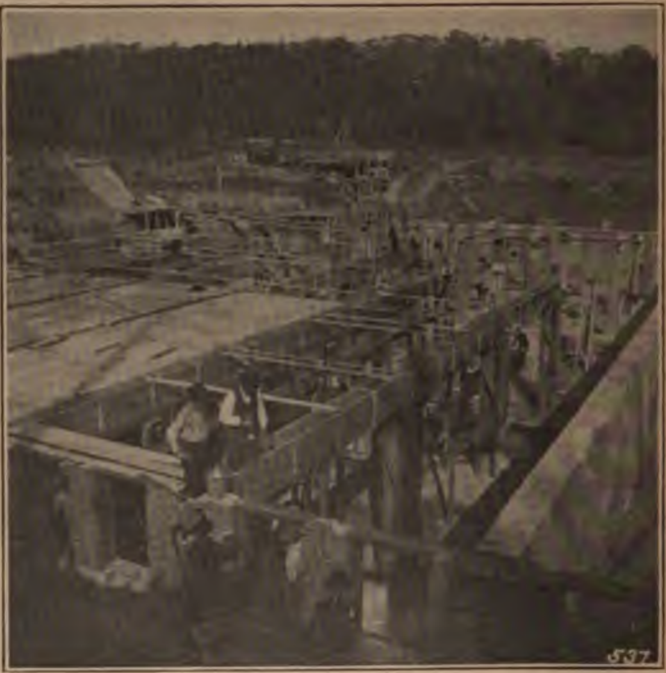


FIG. 7. COLUMNS AND ROOF FORMS.

A similar form of construction is followed with the steel in the slab; the rods being near the top of the slab over the beams and near the bottom for the central portion between the beams.

The walls are built in sections about 20 feet in length except where two walls intersect; here they are built in the form of an L or a T, each leg of which is of the standard length. They are built monolithic from bottom to top. The division walls between the beds are 18 inches in thickness above the sand level, widening to 26 inches at the base; between the beds and the pipe gallery they are 18 inches, widening to 22 inches, and the outside walls are 20 inches, widening to 40 inches at the base. All of the walls are thus battered on the side towards the filters, below the sand level, to facilitate the packing of the sand against the walls.

The different sections of the walls are joined by a tongue and groove joint, 6 inches in width and depth; the sides of the tongue being slightly beveled to admit of the tongue slipping as the walls expand and contract. To facilitate the slipping, the sides of the grooves are painted, and, to prevent the tongue and sides of the groove from breaking off, ¼-inch steel rods are built into them about 1 foot apart.

The forms are usually taken down the day after they are filled, and any rough places on the face of the work is filled with a thin mortar of cement and sand, the wall given a good coat of grout applied with a brush, and then floated with soft wood floats.

The clear water well, which is located between the filter beds and the pump house, is about 240 feet in length, about 45 feet in width and 14 feet in depth. Its capacity is about 800,000 gallons when filled to its normal water level, or about one-tenth of the average amount of water supplied per day from this plant.

It is similar in its construction to the filter beds except that there is no brickwork, except in the gate houses, the roof being placed directly on the concrete walls, which vary from 15 inches in thickness at the top to 63 inches at the base, and the whole is covered over with earth, 2 feet in depth, forming a subterranean chamber.

The inlet pipe, 48 inches in diameter, from the filter beds, enters near the southwesterly corner, where is built an inlet chamber. This is about 15 feet by 18 feet in plan, the four sides of which are so constructed as to form a weir over which the water flows into the well proper, when the filters are run under ordinary conditions. This enables a constant difference of level to be maintained between the water in the well and the beds, thereby securing a uniform rate of filtration.

A 48-inch by-pass, closed by a sluice gate, connects the inlet chamber with the main well. By opening this gate the level of the water can be drawn down in the inlet chamber, creating a negative head on the filters and thereby increasing the [illegible] million gallons [illegible]. This is provided [illegible] the plant occasioned [illegible] of the other [illegible].

[illegible] chamber with the [illegible] enabling the main portion [illegible] for repairs, without [illegible]

[illegible] diameter and draws water [illegible] the well. It is con- [illegible] the well and about [illegible] branches, a [illegible]-inch [illegible] one to the water [illegible] discharging into a sewer in [illegible] the well when- [illegible]

[illegible] manner and the [illegible] for inverting the [illegible] corner of each [illegible] as the well [illegible]

[illegible] which the [illegible] feet in length [illegible] in length [illegible] in length, is [illegible]

[illegible] cement [illegible] for supplying [illegible] by [illegible] above.

[illegible] feet in the [illegible] feet in the middle, below the sides, thus leaving a sidewalk, 3½ feet in width on each side and giving a grade to the floor of the depressed portion from the ends toward the center, at which point is placed a receiving basin connected with the sewer; thus providing for the drainage of the gallery.

There are four lines of mains in the pipe gallery, placed one above another. The lower line is the effluent pipe, varying in size from 24 inches in diameter, where it receives the water from the two end beds, to 36 inches in diameter where it discharges into the main effluent at the center of the gallery. This last pipe is 48 inches in diameter, dips down and passes under one of the northerly tier of beds, and discharges into the inlet chamber before mentioned. The effluent pipes receive the water from the main collectors in the beds through 16-inch laterals, inserted in each of which is a Venturi meter for measuring the rate of flow from that bed.

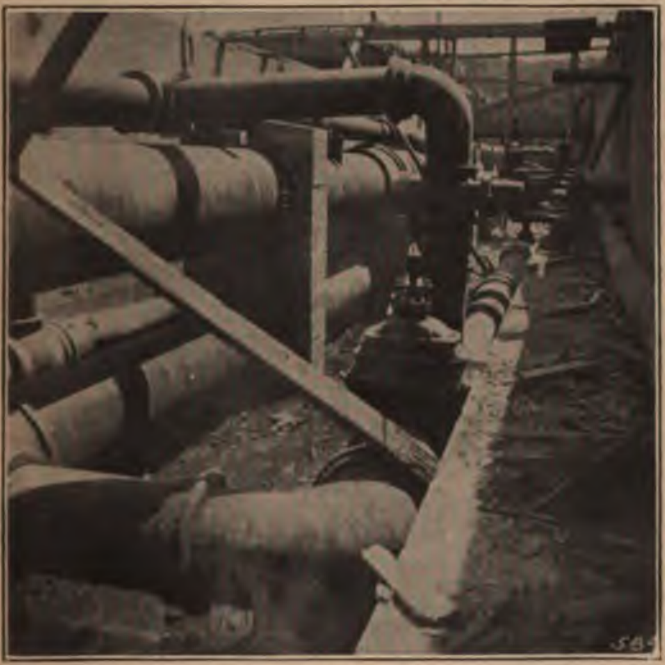


FIG. 8. PIPE GALLERY.

Above the effluent pipe is the raw water main. This varies from 36 inches in diameter, where it enters the gallery at its easterly end, to 20 inches in diameter, where it supplies the two last beds at the westerly end.

Each bed is supplied from this main by a 12-inch lateral terminating in a balanced float valve for maintaining the surface of the water on the beds at a constant level.

An overflow pipe, 12 inches in diameter with a funnel-shaped opening 24 inches in diameter, placed in one corner of each bed and connecting with the sewer, guards against the water overflowing into the operating gallery in case of any derangement of the automatic valves.

The inlet pipes discharge into an inlet chamber, 4 feet square, just inside the filter beds. The upper 2 feet of these inlet chambers is built up of movable concrete blocks, 2 inches square and 4¼ feet long, the ends fitting into rabbets made in the pipe gallery wall and the piers forming the outer corners of the chambers. The object of these being to maintain the top of the inlet chamber at the same level as the sand surface.

Both the effluent and the raw water mains are connected with an 18-inch double strength, vitrified pipe sewer, which runs under the floor of the pipe gallery. Through the connection with the raw water main the water can be drawn off from the filter beds down to the sand level; and through the effluent connection it can be drawn out of the sand, whenever it becomes necessary to clean a bed.

Above the raw water main is a 10-inch pipe connected with each 10-inch effluent branch. This provides means for filling any bed, from beneath, with filtered water, without using water which has been pumped up into the reservoir.

Above the refill pipe is an 8-inch main with 6-inch laterals running almost the entire length of each bed. This supplies water from the Prospect hill reservoir, for conveying and washing the sand.

The three lower lines of pipes are supported on concrete piers built up from the pipe gallery floor; the upper is suspended from the beams of the floor above.

A line of 3-inch pipe, for carrying sand, also runs nearly the entire length of each bed, but it is connected with a moveable pipe in the operating gallery.

All of these various lines of pipes are provided with valves for regulating and controlling the operation of the filters.

The registering apparatus, one set for each bed, consists of three wrought iron pipes, 8 inches in diameter, secured in a cast iron base standing on the pipe gallery floor, the pipes opening into a manhole built into the floor of the room above. These pipes are connected at the bottom by ¾-inch pipes, respectively, with the water in the filter beds, in the inlet chamber and the throat of the meter. Floats in the pipes connected by wires with a suitable mechanism in the operating gallery, indicate on a dial the loss of head in passing through the sand, and the rate of filtration.

The second, or ground floor, is the operating gallery, and contains the gate stands for operating the valves in the pipe gallery beneath, the indicators just mentioned and the sand washing machine. The gate stands are ranged along the sides of the gallery, being connected with the gates beneath by bevel gearing where necessary. An open space is thus left through the center of the gallery to provide room for the sand washing machine and the passage of teams, which can be admitted by wide doors at each end of the room.

This room is 13 feet in height, and is provided with two rows of windows on each side; those of the lower tier opening into the filter beds and the upper opening outside over the roof of the filters. A wide sliding door and a short flight of concrete steps affords access from the operating gallery to each filter.

The walls of this room, not occupied by doors and windows, are faced with white enameled brick, and the ceiling is sheathed up with white spruce, varnished; thus securing cleanliness and a maximum of reflected light for lighting the filters.

The floor of the operating gallery is laid with a dip of one inch from the sides to the center, thus forming a shallow gutter in the center, and this latter is given a grade, longitudinally, of 1 inch in 40 feet, draining to five 10-inch openings in the floor, connected with the sewer; these receive the overflow from the washing machine.

Openings, 2 feet by 8 feet, covered by wrought iron gratings, are placed at frequent intervals along the sides of the gallery to light and ventilate the pipe galley beneath.

The third story is divided into rooms for use as chemical and bacteriological laboratories and offices. A gravel roof covers the central building.

A bridge connects the high ground near the northwesterly corner of the beds with the roof of the northerly tier of filters, and a similar bridge connects the roofs of the two sets of filters at the westerly end of the operating gallery. These provide means for getting teams on to the roof of the filters. These bridges are built in the form of arches but they are arches in architectural effect only, being of reinforced concrete beam and slab construction.

[illegible] are used in the work. [illegible] mortar composed of one [illegible] screenings such [illegible] inch mesh; the same [illegible] under side of the roof [illegible] bases of the walls. For [illegible] bottoms and columns [illegible] same mixture, in which is [illegible] will pass the crusher [illegible] probably makes [illegible]

[illegible] inch to 2½ inch is [illegible] the 2½ inch [illegible] material had a [illegible] that the box [illegible] remains the next [illegible] screenings, only a [illegible] previously [illegible] The sand is not [illegible] large to pass a [illegible]

[illegible] concrete [illegible] of the loose [illegible] mortar the [illegible] and the mix- [illegible] is usually [illegible] being given

The concrete is mixed "wet," and very little tamping is required, but a thorough spading is given along the sides of the forms to secure a smooth and tight surface.

The concrete is mixed in batches of about two-thirds of a cubic yard. It is dumped from the mixer into a "cyclopean concrete bucket" and is then swung by a derrick to its destination. Two derricks, with booms respectively 65 feet and 59 feet, are used, one on each side of the mixer. One or the other of these is able to reach nearly all portions of one bed at one set-up. In building the roof, the concrete is dumped from the bucket into a steel dump car which runs on a light industrial railway track.

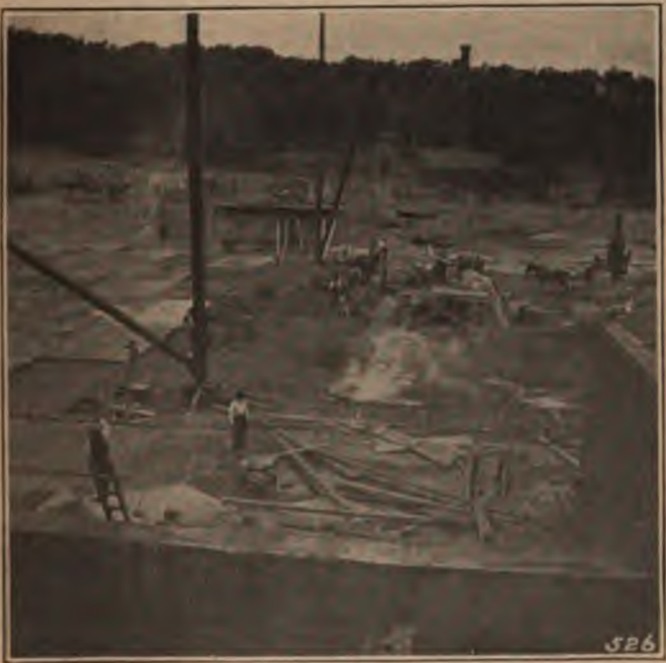


FIG. 9. ARRANGEMENT OF PLANT FOR HANDLING CONCRETE.

Alpha Portland cement has been used exclusively; the stone for the concrete is obtained from a trap rock quarry located about 300 feet from the work; sand is obtained from a bank on the property of the company about a mile and a half from the filters.

The machines for handling and washing the sand have not yet been constructed, but the plans provide for three separate machines for that purpose. The first, the ejector, consists of a conical shaped hopper about 3 feet in diameter at the top, about 15 inches at the bottom and about 3 feet in height. A perforated pipe placed vertically in the center of the hopper and connected with the high pressure main, serves to spray the sand as it is filled into the machine and convert it into a semi-fluid condition, so that it can be washed by the ejector pipe, which is placed at the bottom of the hopper, force it through the discharge pipe and carry it to the washing machine located in the operating gallery.

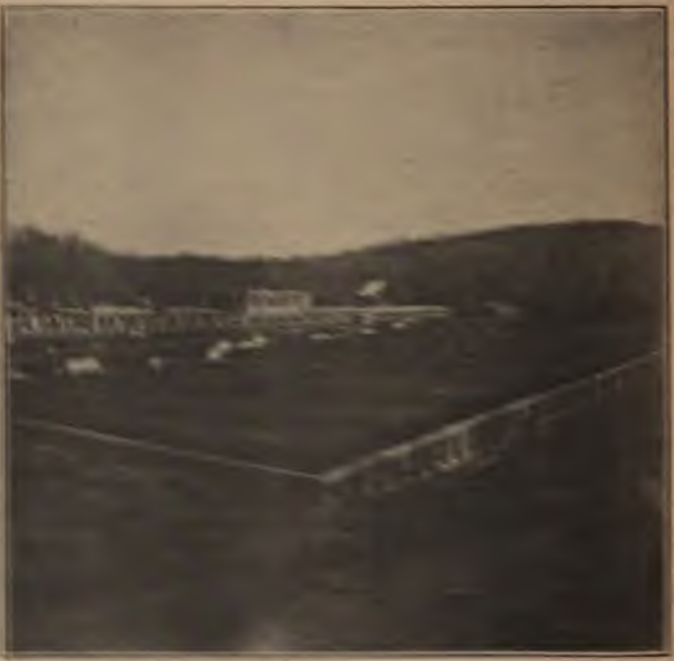


FIG. 10. VIEW OF PLANT NEARLY COMPLETED.

The latter consists of practically two of the ejectors just mentioned, in combination with suitable troughs for separating and removing the dirty water. The first ejector in the machine carrying the sand into the second ejector, and the latter, in turn, sending it along to the receiver placed in one of the beds.

This latter consists of a hopper holding about 5 cubic yards, with valves at the bottom for drawing off the sand, and an overflow weir at the top for separating the surplus water. The sand sinks to the bottom of the receiver, where it is drawn off, through the valves mentioned, into wheelbarrows for distribution in the beds. The receiver is to be suspended from the ceiling, sets of four eye bolts being built into the roof at three different points for that purpose, and the roof being reinforced at these points by steel concrete beams built in connection with the main slab and extending above it.

This provision for handling and washing sand obviates the necessity of providing an open court, such as is a prominent feature of other slow sand filter plants; a filter bed, one of which will always be out of commission, and the operating gallery taking its place.

The grading and pipe laying is done by the water company, by day work; the remainder of the work being done by contract with the Eglee-Bunting Company of Boston.

The cement is furnished by the contractor, but is paid for by the company at a stipulated price; the cement being receipted for by the inspector as it is delivered at the mixer. The contractor thus being responsible for it until it comes on to the work. That marrow bone of contention between engineers and contractors, the cement question, thus being consigned to the "soup."

It is expected that the portion of the work, now under contract, will be completed sometime in October, after which the work of putting in the gravel and sand filling will be done, probably by day work.

GREENWICH SEWER SYSTEM.

THE OUTFALL SEWER AND EAST SIDE SEWER TUNNEL

By J. Louis Gregory.

The settlement of Greenwich, Conn., is so situated topographically, that it requires two main or belt sewers, known as West Side and East Side, which encircle the borough proper and receive the laterals which enter from the different streets. These sewers, for practically their entire length, follow streams, and in this way drain not only the borough, but surrounding properties. It might be well to state in passing that these are sanitary sewers, not a combined system.

At their junction at tide water they enter one outfall sewer, and in this sewer [illegible] which are seldom encountered, if ever, [illegible]. This sewer is composed of [illegible] feet of [illegible] vitrified pipe, 1,000 feet of 24-inch vitrified [illegible] feet of double 12-inch cast iron pipe.

The [illegible] which is in the highway, is close to a stream known as Horse-Neck brook, which had to be crossed [illegible] with tide water, and the grade [illegible] was high-water mark. The [illegible] construct a siphon at this point, as [illegible] grade in any structure [illegible] freshets and ice. This siphon [illegible] consisted of two lines laid side by side [illegible] of ordinary hub and spigot [illegible] the manhole at the [illegible] on a grade of 1 in 200, [illegible] first, two gates of ordinary [illegible] pipe, and then two [illegible] later for connections with [illegible] the relative positions.

[illegible] to clean the siphons [illegible] the 12-inch gates, an [illegible] been constructed [illegible] manhole at the junction and leading to the brook, and open the water gates, one or both, which were between the 4-inch hub and the water main, and bring a pressure on the siphon sufficient to force out any sediment that might collect there. From the grade of the pipes which left the manhole, a drop of 8.2 feet was accomplished through two ¼ bends to the bottom of the siphon, which was laid 2 feet under the bed of the brook on a grade of 1 in 200; the rise on the other side being accomplished in the same manner as the drop, through a distance of 8.2 feet, making the drop and rise the same, the pipes entering the bottom of a manhole, and the siphon working under a head equal to the difference of grade in the two ends, or practically 0.5 feet.

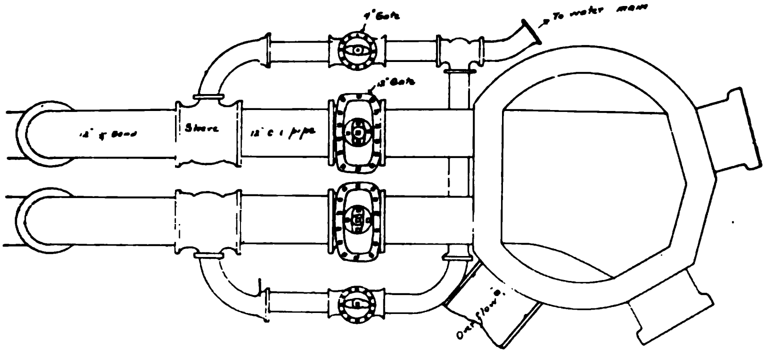


FIG. 1.

The construction of this siphon was carried on at low tide only, the stream being diverted first one side and then the other, to allow of the digging of a trench and laying of the pipe on a natural foundation of gravel. From the outlet of this siphon the 20-inch vitrified pipe was laid on a grade of 1 in 600 along the shore road, to a manhole at the beginning of another siphon. At this point the sewer changed direction, crossing a government channel 400 feet wide, then across Grass Island, to the far point which was the outlet at the harbor line.

Consent was obtained from the government to lay a double line of 12-inch cast iron pipe across this channel at a depth of 6 feet in the clear below mean low water, and this was accomplished in the same manner, namely a siphon, as the crossing of Horse-Neck brook. The first plan was to carry the sewer about to the harbor line on grade and then drop down, and up on the other side, very similar to the other siphon, but in construction the plan was modified, and after leaving the manhole at the road, where all the gates and water connections were laid precisely as they were at the brook crossing, the pipe was laid for about 125 feet on a uniform grade of [illegible] to the low point of the siphon at the harbor line [illegible] feet from the manhole, then across the channel [illegible] and up through a quarter bend to the bottom of a manhole on Grass Island, a rise of [illegible] feet [illegible] the 24-inch pipe was laid [illegible] the first 50 feet of this was in a [illegible] 5 feet below the surface [illegible] of an island as [illegible] the other [illegible] later

[illegible] was encountered [illegible] 15 feet and then [illegible] here the [illegible] a number of [illegible] center to center in [illegible] These were capped with [illegible] to the [illegible] stringers [illegible] piles [illegible] enough [illegible] only [illegible] about [illegible] was found [illegible] depth [illegible] was dressed at [illegible] sand and [illegible] inches, to [illegible] the pipe was [illegible] being filled [illegible] arch resting [illegible]

As a final protection to this arch, the portion remaining above the mud surface was mounded over with mud. Line and grade was given by nailing two uprights to the side of the timber floor every 50 feet, and nailing on cross pieces at a uniform grade above the flow line, and lastly centering these pieces.

In the construction of the siphon across the government channel, conditions were far different. This channel had never been dredged out, and from the road to the island was one continuous mud flat about 4 feet above low water, except a narrow channel which was about 3 feet lower. For this entire distance mud was encountered to a maximum depth of 26 feet, overlaying a hard gravel, which rose rather abruptly at the island and also at the road.

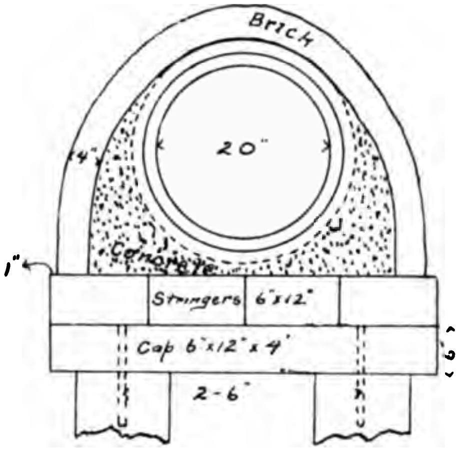


FIG. 11.

This 525 feet was all double 12-inch cast iron pipe laid on a pile foundation, the piles being sawed off at the proper grade and capped with a 6-inch × 12-inch cap 4 feet long. The construction was accomplished by driving piles at high water, in pairs 2½ feet apart, center to center and 12 feet longitudinally, care being exercised in their driving to keep them vertical, and in this way as near a correct position as possible where they were to be capped, which was about 12 feet below the surface. After the piles were driven, a section of 36 feet in length, starting at the island, was taken and 2-inch sheathing 12 feet long was driven outside of the piles, making the trench 8 feet in the clear. The digging was then started, and at every depth of about 4 feet rangers were placed inside and braced about every 6 feet. The first two sets of rangers were 4 × 8 inch with 4 × 6-inch braces, the others 6 × 8 inch rangers with 6 × 6-inch braces.

As the work was only carried on at low tide, a 6-inch steam pump was installed on the island and the trench pumped out as the tide fell. The first section on the island end encountered gravel, and necessitated pumping almost continuously. After this section nothing but mud, which was just solid enough to shovel, was encountered, and here trouble began.

It was found that the sheathing was not long enough; [illegible] was so great as to [illegible] in this way caps [illegible] were forced up. [illegible] the same time the [illegible] the sheathing [illegible] the rangers still [illegible] three [illegible]

TUNNEL.

The East Side sewer tunnel, which is 500 feet long, is 12.0 feet deep at the easterly shaft and 25.3 feet at the westerly shaft, and at a maximum depth in the center of 63 feet below the surface. From the two shafts, which were afterwards manholes, the sewer was in open trench. The tunnel, for its entire length, was in a kind of gneiss, dipping about 45° E. As the easterly shaft was in private property, and the westerly one in the highway, it was decided to drive the tunnel from that end so as not to obstruct travel. This, however, was the wrong way of the rock, as well as down the grade, which was 1 in 300.

As the drilling of the tunnel and the sewer contract were under separate contractors, the contractor for the tunnel was obliged to sink a shaft and work through that. The contract called for a tunnel no less than 4 feet wide and 5 feet high, the contractor to be allowed to select his own cross-section and dimensions, provided the line and grade of the floor conformed to the grade given and the sides were symmetrical with reference to the center line. The power to be employed in driving the tunnel was compressed air.

A plant was established about 125 feet from the shaft, comprising a large upright boiler which furnished steam to an Ingersoll-Sargent compressor and a single drum hoist, a large compressed air tank provided with safety valve and drip cocks was set up near the compressor, and a derrick at the shaft for hoisting refuse. It was afterwards found the boiler was not quite large enough to run the plant at its full capacity. After two or three headings water was encountered so that a steam siphon was installed in the shaft, which was below grade enough to allow the digging of a trench close to the foot wall in the tunnel, thus draining it.

The line of tunnel was produced back of the shaft for a certain distance, there being a bend in the sewer pipe at the shaft, and from this point and one on the summit, line was taken and carried into the tunnel by first setting a point on the edge of the shaft, which was 10 feet in diameter, and from this point setting one in the portal. From this point at the bottom and the one on the edge (which was as far back as could be seen) the line was taken and carried forward.

points being put in about 50 feet apart, consisting of a plug set in the roof and centered. These were over the axis, and their plus and distance above the flow line given the foreman. Line and grade was given with a Stackpole instrument, by sighting at a light placed back of a plumb bob string for line, and back of a tape, the lower end being weighted to hang plumb, on which was a sliding cardboard, the upper edge being set for grade.

[illegible] was about 6 feet square, [illegible] as this was most [illegible] part of the [illegible] used as the drillers [illegible] other men, and [illegible] for the night gang [illegible] handling of the [illegible] was first ready [illegible] shift of drillers [illegible] progressing at an average [illegible] the headings [illegible] a little beyond [illegible] the center, but [illegible] the side along [illegible] first, then the [illegible]

[illegible]

When the manhole at the last heading was sunk by the sewer contractor, it was found that the rock had dropped very abruptly here, and that only 5 feet remained between the earth and the last heading. Line, grade and distance was about 1 inch off from this manhole center, no extreme care being taken, however, in running them. In the construction of the sewer an arch was turned in the side of the manholes running back to connect with the rock face of the tunnel, thus giving an entrance to it. and provision was also made to take away the water from the tunnel, not through the sewer but by a separate drain. In the building of this East Side sewer, as well as all others, care was taken to make the joints as tight as possible, even to the placing of muslin strips around the joints after they were made so as to hold the cement in place, which is a good practice in wet ground, as the question of ground water would play no small part should the future demand disposal works of some kind.

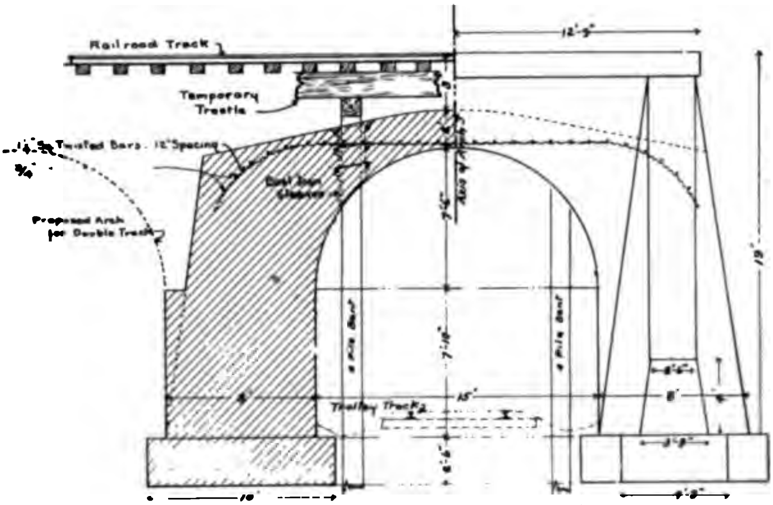
THE NORTH HAVEN-WALLINGFORD EXTENSION OF THE CONSOLIDATED RAILWAY COMPANY.

By Edward E. Minor.

The Wallingford extension of the Consolidated Railway Company consists of seven miles of track, connecting Montowese with Wallingford. Starting at the end of the Montowese line running from New Haven, the new line passes along the highway for about a mile, then passes under the Air Line Railroad and over Pine River, and thence through private way a distance of about two miles to North Haven. Through North Haven Center the location is on the highway, but after leaving that, it continues on private way about four miles to Wallingford, where it connects with the Meriden Electric Railway, now owned by the Consolidated Railway Company.

This connection possessed rather more than local interest, for to it fell the distinction of being the last link in a continuous line of trolley roads from New York to Boston. Outside of the town of North Haven, there are but few houses on the line. Its location is on the easterly side of the Quinnipiac valley, where the sand plains compensate for their utter lack of way traffic by exceptional opportunities for line and grade. The alignment consists practically of but four tangents, connected by large easy curves. One of these tangents is about two and one-half miles in length, and for the greater part of the way has a grade of but ten feet in a mile. There are four turnouts on the line, each about half a mile in length. These have standard split switches, and as the double trolley wire, which extends over the line, does away with overhead switches, cars may run through them at full speed. The rail is an 80-pound Am. Soc. C. E. section in 60-foot lengths, with the joints driven together as close as possible and the track filled in. The roadbed was graded to a subgrade 18 inches below the grade of the rail, 18 feet in width for single and 28 feet for double track. The track was then ballasted, with a five-foot shoulder outside the rail. Most of the grading was completed for double track. Span wire was used for overhead construction and all trolley poles set for two tracks.

There are five concrete arches on the line and two steel bridges. All pipe culverts were protected at each end by a concrete headwall 12 inches in thickness. The arches and the abutments of the steel bridges were built of 1 : 2½ : 5 broken stone concrete, except in connection with the reinforcements in the Air Line arch, where a 1 : 2 : 4 mixture was used.

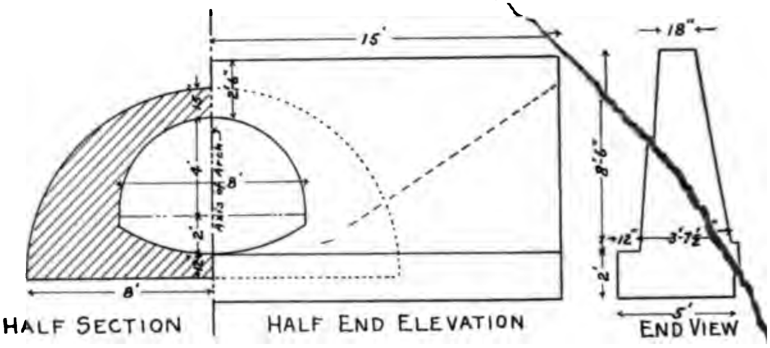


HALF SECTION HALF END ELEVATION

ARCH UNDER AIR LINE R.R.

FIG. 1.

The line passes through a reinforced concrete arch of 15 feet span under the Air Line Division of the N. Y., N. H. & H. R. R. at a point where the steam road is on a high fill. Piling was driven down through this fill for a short distance each side of the center line of the arch, and a temporary trestle constructed. Two trenches, strongly sheathed and cross-braced, were then carried down to the foundation of the arch, and each abutment built up to the springing line. The earth core remaining between was then taken out to the springing level and the arch turned. Two four pile bents came down through each haunch of the arch. In order to guard against vibration from passing trains heavy cast-iron sleeves were bolted around each pile, leaving a two-inch space between the pile and the sleeve. This was entirely successful in keeping the concrete undisturbed. Twisted steel bars were placed transversely with the axis of the arch, coming close to the soffit of the arch at the center, and running back horizontally to the extrados, from which they curved down into the abutment. These held the two abutments rigidly at the top against the thrust of the arch, no dependence being placed on the back fill. They also added greatly to the strength of the arch under moving loads, which were of some moment, as the arch is in a hollow between two heavy grades. The arch has a skew of 30°, and as further reinforcement a system of longitudinal bars was carried through the arch barrel. The two pile bents which came through the arch were so spaced as to allow the passage of trolley cars between them. All loads were carried by the trestle until the concrete had set sufficiently, when the piles were cut out and the sleeves filled with concrete. The passage of trains was at no time interfered with.



TYPICAL 8' CULVERT

FIG. 2.

At Pine River a single track, deck, plate girder bridge was constructed of 50-foot span. The abutments were built for double track. The track crossed the river at such a slight angle that the river bed had to be changed for quite a distance. The new location of the river made very nearly a right angle turn under the track, and in order to protect the slopes from scour very heavy wingwalls were built on the upstream side. The abutments were carried down about seven feet below the river bed in a sheathed trench. The only difficulty met with was from water coming up through the bottom. This was remedied by constructing a blind drain in the bottom of the abutment, through which a pulsometer was able to keep the water level below the surface of the stone, upon which the concrete was placed. The drainage area above the bridge is about 22 miles.

A light highway bridge of rolled beams carries the Sacketts Point Road over the track. The abutments are of concrete. Three eight-foot semicircular arch culverts were built on the line, two of which rested on quicksand. These were built with a concrete invert and each headwall carried down below the foundation to form a cutoff wall.

At Worton Brook the location of the trolley was between the Hartford Division of the N. Y., N. H. & H. R. R. and the main

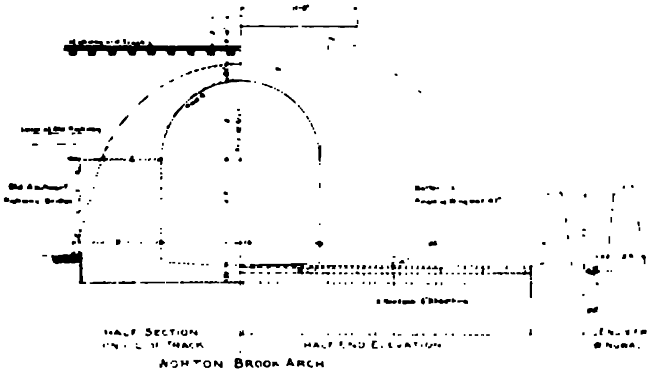


FIG. 3.

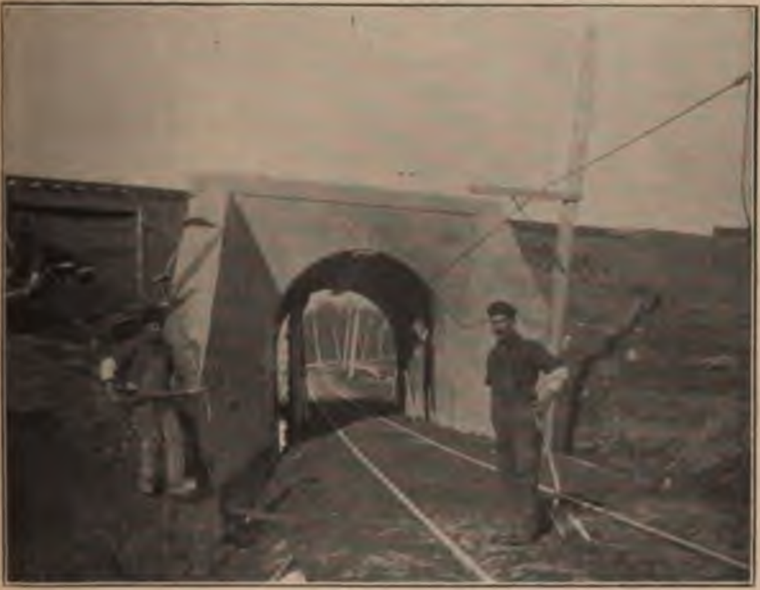
iway between Wallingford and New Haven. There was a icircular cut stone arch, 16 feet span, under the railroad, a wooden truss bridge for the highway. As this was too e to the railroad to allow the trolley to be carried through separate bridge, at the grade desired, a concrete arch was igned of the same span as the railroad arch, and long enough the highway. The drainage of the brook above this point out eight square miles. A sod dam was built a short dis-ice above the bridge and a 2-foot × 5-foot wooden flume nstructed to carry the flow of the stream. The foundation as quicksand.

The railroad arch, which was built about fifty years ago, sted on a cribwork of oak beams planked over At the ends f the arch an apron was built, sloping down into the bed of the brook. This timber when uncovered was as perfect as the day it was put in. The foundations of the highway bridge were higher than those of the railroad arch and not as well preserved, although put in much later. They consisted of two sets of 12-inch logs, crossed, with a row of sheet piling driven in front. The foundation of the proposed arch came about a foot below that of the railroad arch, and three feet below the abutments of the highway bridge. In front of these a body of concrete was first laid, 6 feet wide and 2 feet deep. The treacherous character of the foundation was fully appreciated here. As the bottom was uncovered the abutments settled down from 3 to 6 inches, while the bottom would begin to rise up and break out into small craters, which were very interesting. At first appearance this seemed like a fairly stiff clay, but a very little working in it transformed it, so that it possessed about the same consistency as jelly. Great care was taken not to disturb it. The placing of these two blocks of concrete seemed to balance the pressure, so that no further movement of the abutments was noticed. Between these the invert was put in, in transverse slices about 5 feet in width, the

WORTON BROOK ARCH.

longitudinal joint on each side being covered by the arch abutment. The upstream face of the invert and the wingwalls was protected at the bottom by two courses of 2-inch sheathing 7 feet in length and secured to the concrete by 1-inch bolts. The abutments were carried up to the level of the springing, which came just below the level of the highway bridge. This was then taken down and the arch turned.

With the exception of the superstructures of the Pine River and the Sacketts Point highway bridge, all structures on the line are of concrete, and considered permanent. The concrete was put in wet, into forms which were substantially watertight. A mixture of 2-inch and ¾-inch stone was used, the proportions of which were judged so as to always keep the concrete full of mortar. The mixing was done by a No. 13 Ransome mixer.



ARCH UNDER AIR LINE R. R.

The grading and the concrete work was done by B. D. Pierce, Jr., Co., of Bridgeport. The line work and track were done by the Consolidated Railway Company. The extension was built under the general direction of John K. Punderford, General Manager of the Consolidated Railway Company. Albert B. Hill was consulting engineer, and the writer engineer in charge.

THE CHESTNUT STREET SEWER OVERFLOW, NEW HAVEN.

By Henry J. Kellogg.

Before entering upon the description of this work, I feel compelled to say a word about the accompanying details in plan and section. When the original drawings were made it was not supposed that they would ever be used to illustrate a published article. They were arranged and crowded to economize space, that the blue prints might be of as convenient a size as possible and yet be of such scaled proportions as to be easily read. The reduction in size from the original emphasizes the crowding.

This overflow, built in 1903, is but one of several that have been recently recommended. The most costly overflows, the ones that will be the most difficult to construct and that are the most needed, are not yet ordered. It is now probable that some of them will be ordered this year.

The location of this overflow may be found on Plate II accompanying Mr. Jackson's article in this book. Other overflows recommended are: One starting from the corner of State and Water streets to cross under the tracks, reaching tide water by the most convenient route and then extending to the end of the Meadow street outlet which will sometime be extended to the harbor line. Another running from the corner of Canal and Munson streets, through Munson street to Beaver Brook. The present sewer in Munson street would be replaced by a small sewer to take sewage only to Canal street. Another overflow will be in Oak street from the Boulevard to West River.

Especially during the last five years have we felt the need of more outlets. In that period the roof area has been greatly increased and nearly all of our so-called "permanent pavements," brick and asphalt, have been laid. Also the small yearly increase of sewers in use has added to the burden of our trunk sewers. When manhole covers are blown off and streets and cellars are flooded, it is time to take measures for relief. These troubles come during rains that have periods of extra heavy precipitation and during sudden, violent showers. By coincidence, or on account of meteorological reasons, all but one of our worst rains have occurred at flood tide. One that flooded us had a rate of fall, for about twenty-five minutes, of nearly four inches per hour and came at half tide. A heavy southeasterly wind had forced the water up to its average flood height. The heaviest rate noted was during a thunder storm, that came when the tide was in, when the rain fell for ten minutes at the rate of four and eight-tenth inches per hour. Extra high tides completely submerge all outlets and the average tides cause a setback. So our low-lying trunk sewers work under a head (at times) both from tide effect and from surcharging.

For this overflow we asked an appropriation of $15,000 and got $13,500. Left without sufficient money to carry out all of our original intentions, we were obliged to pare down cost of construction and to lop off the outer end of the overflow as much as we could and yet reach beyond the tide line. Ultimately this overflow will extend to the harbor line, following the lines and lying in the extension of Chestnut street.

Waterside Park and the extension of Chestnut street are both entirely on made land. The filling lies on a stratum of mud that increases in thickness from nothing, at or near the south line of Water street, to twenty feet at the edge of the fill when we built the overflow; a distance of about 700 feet. Beyond was soft mud, exposed at low water, increasing in depth from the twenty feet at the edge of the fill to about forty feet at the harbor line. We had to drive piles up to about forty feet from Water street.

The 30-inch sewer, curving out from Chestnut street into Water street and continuing thence to the 36-inch sewer beginning at Franklin street, is egg-shaped in section and built of 4-inch brickwork. It was known to be in poor condition, and therefore the customary method of constructing an overflow by making a long, narrow, horizontal opening in it, at or just above the springing line of the arch (called a dam) was considered inadvisable. Instead we built a 24-inch, circular, brick overflow sewer alongside the 30-inch sewer in that block and extended it, for a short distance, along the 36-inch sewer.

The connections were made with the 30-inch and 36-inch sewers by means of 10-inch vitrified, curved pipes called eighth bends. We could have built a dam to relieve the 36-inch sewer, as that was of 8-inch brickwork, but the pipe connections figured out cheaper and were easily made. By using these bends the spillways were raised to the last inch and we avoided cutting higher into the arches. So far as we know, this method of constructing an overflow is new. The 24-inch overflow is of 8-inch brickwork, where the connections were made, and the rest has a 4-inch arch and an 8-inch invert. It was laid on a foundation or cradle of Portland cement concrete (1:3:6 mixture with a 2-inch limit to the stone). Concrete was also placed between the arches of the sewers and overflow. Owing to the weak condition of the 30-inch sewer, only eight feet of it was allowed to be stripped at a time. The north track of the street railway was kept in use.

The 36-inch overflow, and the reducer, that forms the next portion of the work, is circular and of 8-inch brickwork. A 3-inch timber cradle was laid, except where the connections were made. Three catch basins were cut off from the sewers and connected with the overflow.

The 43-inch "square section" is so termed to designate its shape in section sufficiently to distinguish it from the other types in use and to refer its area of section, as is customary, to the diameter of a circular sewer of the same, or nearly the same area. The construction of the platform is plainly shown in the drawing. The brickwork was laid in mortar (1 to 2 mixture) where the cement was of equal parts of Portland and Rosendale. We have found that by mixing these cements we save expense and get a mortar that is better handled with a trowel; the result, under like conditions to these here described, being as satisfactory as with all Portland. The second-class brickwork comprising the sides and bottom was built of a kind of brick we call "lammies"; the swelled and distorted brick that come from every burning. The only requirement is that they shall be hard and burned entirely through. In the upper four courses, on the inside of the walls, we used first-class brick to draw in with. The use of lammies with a plaster finish was specified in order to cut down cost. The saving appeared to be so insignificant (a matter of doubt in fact) that with a similar

work I would specify either a bonded face of first-class brickwork on the inside faces of the walls and first-class brickwork for the top course for the bottom (leaving out the plastering), or reinforced concrete throughout. The top is calculated to sustain a twenty-ton road roller with a three-foot cushion of earth between the road surface and the concrete. An extra sheet of metal and extra concrete was added at each manhole. The mixture was 1:2:4 Portland, with a 1½-inch limit to the stone. Beyond the filling, in the deep mud, the piles were driven three in a bent. It was our intention to specify that these outer piles should be driven at the commencement of the work, cut off to grade immediately and surrounded and covered with riprap mounded up several feet high. As fast as the stone settled more was to have been added until the settling stopped or the supply of stone gave out. For riprap we fortunately had at hand on the ground about 1,500 cubic yards of broken stone that had been removed from streets where Telford pavements had been replaced with brick and asphalt. It was necessary to do something to steady the piles while the filling was being extended, but we had to leave it more to the convenience of the contractor owing to the lack of funds.

We had feared, even expected, some lateral movement. The riprapping was done, for the greater part, after everything else had been completed and was supplemented with the surplus from the trenches. It was deposited according to our best judgment; figuring up nearly every day toward the very end lest we should exceed the appropriation. But in spite of our care two breaks occurred near the end, about seventy-five feet apart, and the portion between curved toward the eastward; the middle ordinate being fourteen inches. It happened in the night, and before I arrived on the ground the contractor, Mr. Maher, had hauled and deposited enough material to stop the movement. His interest in the success of the work had been evident from the start, and he was willing to do as he did at his own expense, although he was in no way responsible for the accident. Practically the overflow was not impaired and it performs its function as designed, but we wish that little twist was out of it.

The sizes adopted may not seem to be properly related. The 24-inch has a grade of 1 in 400, the 30-inch 1 in 300 (on a curve of 40 feet radius) and the 43-inch a grade of 1 in 700. These grades are simply to prevent deposit from the flow and ebb of the tide, as will be explained farther on. There were five 10-inch tappings made into the 36-inch sewer, five into the 30-inch sewer, and one into the 24-inch sewer that enters the 30-inch sewer at Chestnut street. The three reconnected basins have 10-inch culverts. So we may consider that the overflow should carry off the discharge from fourteen 10-inch openings or intakes, working under a slight head during a heavy rainfall at flood tide. The 24-inch overflow cares for seven of the intakes and the 36-inch for the other seven and the seven accumulated by the 24-inch. The areas of section of the 36-inch and the 24-inch, respectively, are approximately equal to the effective areas of their intakes. The 43-inch, taking only the accumulation of the 36-inch, shows a larger area than would be necessary if the overflow throughout were to work by gravity with a free outlet. But the very high tides, as before mentioned, completely fill the overflow system. Therefore the 43-inch, which will ultimately be 1,400 feet long, was made large (we would have made it larger if we had had more money) to allow the water from the 36-inch to bore its own hole and to discharge nearly as freely as if into open water. That is why I have stated that the grades were given to care for the flow and ebb only.

THE EFFICIENCY OF THE NEW HAVEN SEWERAGE SYSTEM

By J. Frederick Jackson.

The measure of the efficiency of any work is the completeness with which it performs the duties which devolve upon it.

The determination of this efficiency is accomplished by the periodic collection and compilation of statistics of the operation of the work under observation and the analysis of this data with relation to perfect results.

In the case of the New Haven sewerage system, the observations not having been sufficiently extended, we cannot hope, from the data at hand, to reach a satisfactory solution of the problem, but rather to point the way for a more careful investigation.

In the beginning a short sketch of the history of the system will not be out of place. The first mention of sewerage, or, more properly speaking, drainage, was on June 7, 1803.

When in city meeting a committee was appointed, "to examine what repairs are necessary on the street (Chapel street) from Thaddeus Beecher's corner (northeast corner of Church street) to the Market Bridge over the Creek, and the expense necessary therein, and how that expense can be defrayed"; the committee reported back to the meeting June 16, and on July 11, 1803, the meeting voted, that a sewer be constructed from Mr. Hughes' land to the Creek, and that gutters be laid from end of sewer to Beecher's corner.

Dating from 1860, we have a more or less connected account of the construction of sewers in the different streets of the city. Mention is made at this time of work on Broad street and Oyster Point sewers.

In 1861 a Mr. Hartley made a report upon a sewer in George street. This sewer was built during the fall, the entire cost being borne by the city, because, as then stated, "it was thought to be a public necessity." Complaints of inadequate drainage facilities from that portion of the city lying east of the railroad are recorded, particularly from Chapel, Green, Olive and St. John streets.

In 1864-65 mention is made of sewers built in Church, Elm, Grand, Chapel, Temple and Crown streets; in 1866 of a sewer in Chapel street, between Union street and the Mill river.

In 1868 and 1869 Mayor Sperry first mentions bonding the city. Mr. Hartley submits a report on the southeastern part of the city lying easterly of Olive street and southerly of Grand street, and another on the northeastern part of the city lying northerly of the railroad and easterly of Whitney avenue.

In 1870 Mayor Lewis, in his annual message, makes the significant declaration that "the emptying of sewers upon our mud flats will prove impracticable; hence there is not as yet a single sewer in the city that is of any value for general city drainage."

In 1872 [illegible] Chesbrough was engaged to prepare plans for a complete system of sewerage. He found it practicable [illegible] materially change the existing sewers [illegible] system, with some slight modifications [illegible] system with modifications [illegible]

[illegible] of this system, we [illegible] which will give [illegible]

[illegible] starting from the [illegible] its furthermost [illegible] traverse [illegible] seven [illegible] for the [illegible] minutes [illegible] the [illegible] at the [illegible]

[illegible] adults.

[illegible] intensity [illegible] commissions

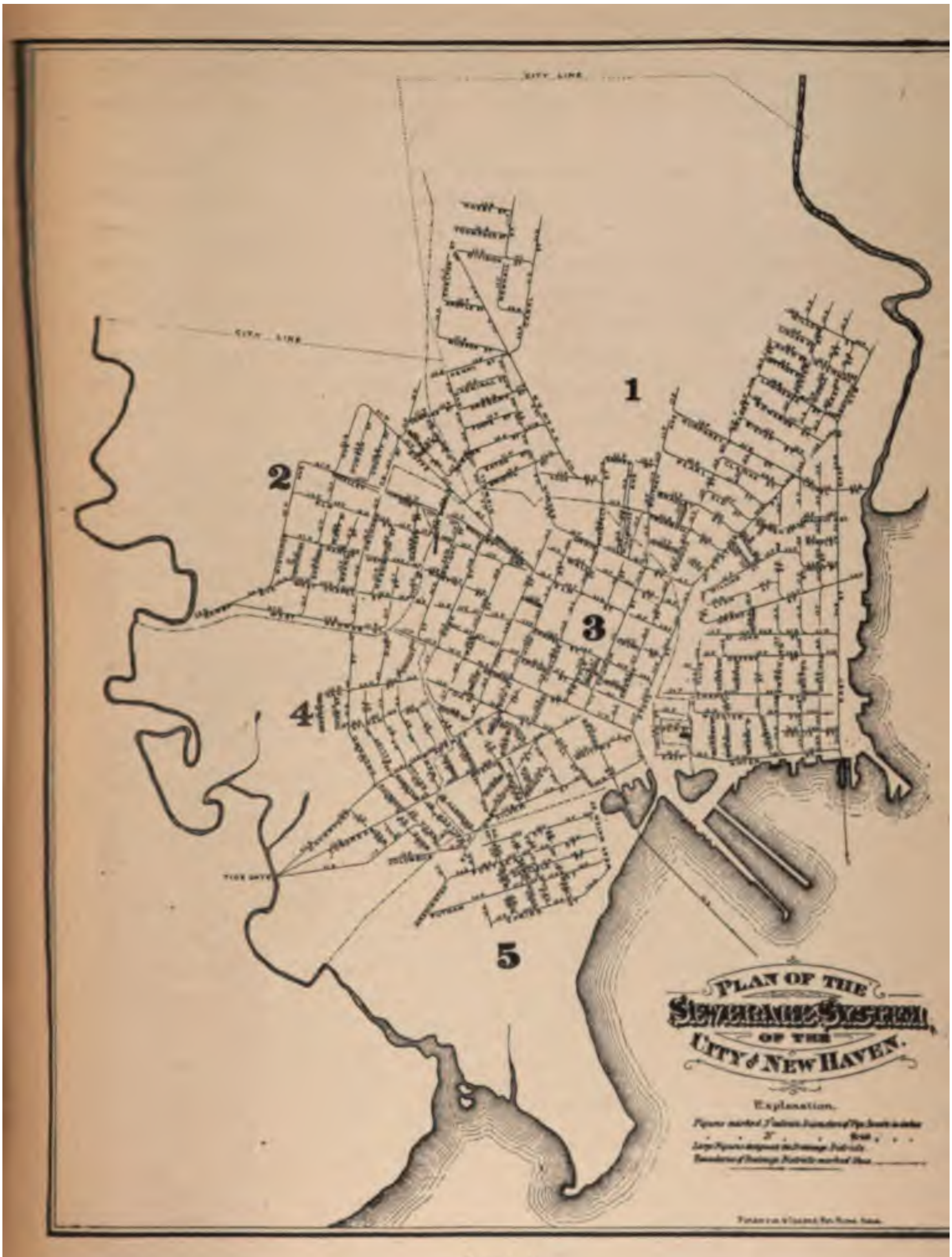

CITY LINE
CITY LINE
1
2
3
4
5
TIDE GATE
PLAN OF THE
SEWERAGE SYSTEM,
OF THE
CITY of NEW HAVEN.
Explanation.
Large Figures designate the Drainage Districts
Boundaries of Drainage Districts marked thus

PLATE I.

and individuals, with widely differing results, due in part to difference in locality, and in part to personal judgment in analyzing the data. For the purpose of this paper, it will suffice, in lack of local data, to use the result of the investigations of Prof. A. N. Talbot of the University of Illinois, of 499 stations in New England and Atlantic states extending over a period of from one to fifty years, and that of Mr. Emil Kuichling, of the local conditions of Rochester and the two neighboring stations.

Prof. Talbot developed two relations, one for rains of rare occurrence, the other for ordinary rains.

From these we determine the following:

	Duration.	Max. Rate, inches per hour.		
		Talbot.		Kuichling.
		Rare.	Ordinary.	
Meadow Street	1 hr. 12 min.	3.4	1.2	.85
East "	1 hr. 21 min.	3.2	1.1	.82
James "	0 hr. 41 min.	5.2	2.1	1.56
Poplar "	1 hr. 6 min.	3.7	1.3	.86
Boulevard	2 hrs. 35 min.	1.8	0.7	0.7

Mr. Kuichling and Mr. Talbot practically agree in ordinary rains of long duration, but differ more widely the shorter the duration.

The amount of rain which reaches the sewers will depend almost entirely on the percentage of impervious area in the district considered.

To arive at an approximation of this we may use the density method.

Assuming that the percentage of impervious area varies directly with the density of population, we may establish a relation between the number of persons per acre and the percentage of fully impervious surface per acre. This relation will vary from 15 per cent. at 15 persons per acre to 80 or 90 per cent. at 75 persons per acre. In this way we get for Meadow street district 56 per cent., East street 39 per cent., Boulevard 33 per cent. and James and Poplar streets 30 per cent. This gives as the amount of rain to be provided for

	Rare.	Ordinary.
Meadow Street	1.90	.67
East "	1.25	.43
James "	1.56	.63
Poplar "	1.11	.39
Boulevard	.59	.23

								9 & 10																		
Feb			.	....	4.13 on 22inst	. .		....			.	2.[illegible] bet. 11&12	..	...	.											..
Mar			1.78 on 25inst	.75 bet & 27	. .		...	.[illegible] bet 9 & 10	....	...			....	2.8[illegible] on 12th										....		..
April			[illegible] bet 3 & 4		. .	2.50 bet. 17&18	. .	.	....	. ..		....	.	. .		.	..		..			.	..	4.03 bet. 20&21	. .	
May		[illegible] bet 12&13	.. .		...	.	. .		....	3.32 on 22d	.	....	...	....					3.10 bet. 3&4		. .	.		..	.	..
June			..	2.81 bet. 6 & 7			....		.	4.70 bet 25&			2.74 bet. 23&24	....	. . .			.			..		.	..		2.77 bet. 20&21
July		.	7 bet. 30&31	....	....	3.[illegible] bet. 11&12		.	..	3.62 bet. 28&29	.	....	....	....	6.15 bet. 30&31 *	2.54 on 25th				...	[illegible] bet 11&12 [illegible] on 22d 3.4[illegible] 28&29		.	...	.	....
Aug ...	2.97 on 14th	8.73 bet 8 & 9	..	....	2.75 on 13th	...	5.12 bet. 17&18		....	.	....	4.51 bet 3&4	2.57 bet. 1 & 2	....	5.67 bet. 21&22 †	.			.	....	... .			3.26 bet. 17&18 2.55 on 24 ††		..
Sept.		.	2.69 on 17th		6.69 bet 4 & 5		2.80 bet. 29&30	....	4.27 bet 11&12	.			.	....	....	.	2.[illegible]5 bet 6&7			3.10 bet. 19 & 20	.			3.48 bet. 10&11 †*†		. .
Oct.			....	2.75 on 4th				...			.		.61 bet. 6 & 7				..	.			.	.	.	....	..	....
Nov. .		2.03 on 10th	.		. . .				....		....	....	2.62 bet. 17&18	. .			.			3.13 bet. 1 & 2		..	....	.	....	
Dec. .	.								...		.		3.75 on 17th **				.			3.21 bet. 14&15	.				. .	

---

* 1.07 in 25 min. on the 4th; 1.34 in 25 min. on the 2d. † 1.75 in 1 hr. on the 21st. †† 1.13 in 24 min. †*† 2.25 in 45 min. on the 11th. ¶ 1.18 in 1 hr. on the 19th. ** 1 in 1 hr. on the 17th.

Now if we knew how often any one of these different rates would occur in a year or period of years we could determine how frequently the efficiency of the sewers would be tested.

The Weather Bureau station has been established at New Haven since 1872. But up to the time of the installation of the automatic gauges, no continuous record of the duration or rate, which are all-important in sewerage work, was kept. Previous to 1872 Prof. Elias Loomis compiled an average for each month for thirty years, but makes no mention of duration or rate. The Weather Bureau has a comparatively accurate record of the excessive rains which have fallen, that is, rains two and one-half inches and over, and also mentions some of those instances in which an inch or over fell in an hour or less. These are shown in Table I.

On Plate III are the curves of three storms which may be considered fair types for this locality. The two classes of excessive rains most interesting to the sewerage engineer are those of great intensity and short duration, and those of light intensity and long duration. That of August 10-11 may be taken as illustrative of the second class, though the total precipitation does not quite equal the requirement for excessive rains. It began at 6 A. M. of the tenth, and continued uniformly until 10.30 A. M. The intensity then increased, and it continued briskly until 12.30 P. M. It then slackened, and ceased at 1.10 P. M. From then until 4.20 P. M. it was cloudy. At 4.20 P. M. it rained gently and continuously until 7.20 P. M., when it ceased. Beginning again at 10.40 P. M., rained briskly, finally ceasing at 3.10 A. M. Duration twenty-one hours ten minutes. Total precipitation 2.02 inches.

That of August 19-20 was typical of the first class. It was cloudy with a trace from 6 P. M. until 12.30 A. M., then the rain began and continued at a gradually increasing rate until 7.40 A. M., when the rate became excessive until 9.50 A. M., 2.07 inches falling, as follows:

5 minutes,	.05 inches.	45 minutes,	.87 inches.
10 "	.08 "	50 "	.95 "
15 "	.13 "	60 "	1.16 "
20 "	.22 "	80 "	1.47 "
25 "	.31 "	100 "	1.67 "
30 "	.54 "	120 "	1.94 "
35 "	.67 "	125 "	2.01 "
40 "	.76 "	130 "	2.07 "

It then gradually decreased, and ceased at 12.35 P. M. Total precipitation 2.99 inches. Duration eighteen hours thirty-five minutes.

The storm of September 14-15 was a very heavy one with two excessive rates, and rain continuous between them. Light rain and mist began at 8.15 A. M., ended at 9.25 A. M.; amount .03 inches. Beginning again at 11.20 A. M., mist and rain continued at intervals, became heavy at 2.35 P. M., and ended at 2.50 P. M.; amount .42 inches. Dense fog from 1 P. M. until 2.50 P. M., gradually disappearing. Rain began again at 9.10 P. M., continued until midnight, was excessive from 10.27 to 10.57; .58 inches falling, as follows:

5	minutes,	.20	inches.	20	minutes,	.46	inches.
10	"	.37	"	25	"	.50	"
15	"	.43	"	30	"	.58	"

Rain continued, ending at 7.50 A. M. on the fifteenth. Was excessive 4.16 to 5.56 A. M., 1.99 inches falling, as follows:

5	minutes,	.06	inches.	40	minutes,	.96	inches.
10	"	.19	"	45	"	1.05	"
15	"	.32	"	50	"	1.18	"
20	"	.44	"	60	"	1.30	"
25	"	.60	"	80	"	1.56	"
30	"	.71	"	100	"	1.99	"
35	"	.89	"				

Duration of storm eight hours fifty minutes. Total precipitation 3.96 inches.

An examination of these curves shows very convincingly that the unit is not the hour, but rather the five or ten-minute interval in the study of storms for sewerage purposes.

As stated above, our data does not tell how often we may expect storms with a rate sufficient to cause a maximum discharge at the different outlets. But from Table I we see that we may expect on an average about three in a year whose rate will be excessive. We do know, however, that the storms of August 19-20 and September 14-15 were the cause of numerous complaints. We know their rates and durations, and it will be interesting to compare them with the theoretical rates before determined. The duration for maximum for Meadow street is one hour twelve minutes and rate 1.2 inches per hour. On

August 19-20 there fell in one hour, 1.16 inches. On September 14-15 there fell in one hour, 1.30 inches. For East street the duration is one hour twenty-one minutes, rate 1.1 inches. On August 19-20 there fell in one hour twenty-one minutes, 1.47 inches. On September 14-15 there fell in one hour twenty-one minutes, 1.56. For the Boulevard the duration is two hours thirty-five minutes, rate .7 inch. On August 19-20 there fell in two hours ten minutes, 2.07 inches. On September 14-15 there fell in one hour forty minutes, 1.99 inches. For James street the duration is forty-one minutes, rate 2.10 inches. On August 19-20 there fell in forty-one minutes, .76 inch. On September 14-15 there fell in forty-one minutes, .96 inch. For Poplar street the duration is one hour six minutes, rate 1.3 inches. On August 19-20 there fell in one hour six minutes, 1.26 inches. On September 14-15 there fell in one hour six minutes, 1.38 inches. Except in those storms of very long or very short duration the actual agrees fairly well with the theoretical, and, as will be noticed, the rates taken are for ordinary rains.

Now, in addition to the percentage of rainfall varying with the impervious area, the sewers must take a certain percentage of ground water through leakage; and a further addition of sewage proper, depending upon the water consumption per capita. They must also overcome at New Haven the conditions resulting from tidal setback in the low-lying districts.

Assuming that the daily water consumption is 140 gallons per capita, and that 75 per cent. of this is sewage flow, we add 100 per cent. for the maximum daily flow which must be taken care of by the sewers. This does not include the flow from large manufacturing concerns, which affect the daily variation. This gives us for the different outlets the following:

Meadow Street		.017	cu. ft.	per acre	per sec.
East	"	.012	"	"	"
James	"	.009	"	"	"
Poplar	"	.009	"	"	"
Boulevard		.01	"	"	"

The infiltration of ground water has been variously estimated from 4,000 to 6,000 gallons for a 6-inch pipe per mile per day. That for brick sewers would be considerably greater.

As to the effect of tidal setback, we have no data to guide us. Disregarding the two, and remembering that an inch of rain per hour is equivalent to a cubic foot per acre per second, we get for the maximum amount finally to be taken care of:

Meadow Street	.687	cu. ft. per	acre	per sec.
East "	.442	"	"	"
James "	.639	"	"	"
Poplar "	.399	"	"	"
Boulevard	.242	"	"	"

In endeavoring to determine the efficiency with which these outlets are doing their work we have calculated the area drained by each (this of itself must be an approximation), and from their diameters and grades their discharge in cubic feet per second, according to the formula of Kutter, using $n = .015$. Dividing the second by the first we obtain the run-off in cubic feet per acre per second, which each outlet will take. Plotted with the acres taken as abscissas and the run-off as ordinates, they appear as on Plate IV. There several subdivisions are plotted on the plate in a similar manner. We have also, for the sake of comparison, plotted the curves corresponding to the following run-off formulas:

Hawksley-Bazalgette

$$q=C\sqrt[4]{\frac{sr^3}{A}} \quad \text{for } r = 1 \quad cr=3.95.$$

Adams

$$q=C\sqrt[12]{\frac{sr^{12}}{A^2}} \quad \text{for } r = 1 \quad cr=1.03.$$

Burkli-Ziegler

$$q=C\sqrt[4]{\frac{r^4S}{A}} \quad \begin{array}{lll} \text{for } r=2.75 & cr=11.61 & \text{built up areas.} \\ \text{for } r=2.75 & cr=9.59 & \text{average city areas.} \\ \text{for } r=2.75 & cr=4.79 & \text{suburban areas.} \end{array}$$

$$S=s\times 1000$$

McMath

$$q=c'r\sqrt[5]{\frac{S}{A}} \quad \begin{array}{lll} \text{for } r=2.75 & cr=8.21 & \text{built up areas.} \\ & cr=3.39 & \text{suburban areas.} \end{array}$$

$$S=s\times 1000 \quad c=\frac{c'}{1000}.$$

New York

$$q=crA^{-.15}S^{.27} \quad \begin{array}{ll} cr=10.59 & \text{completely built up areas.} \\ 8.97 & \text{well built up areas.} \\ 6.59 & \text{suburban areas.} \end{array}$$

The index figures on the plate refer to the corresponding figures on map from which Plate II was reproduced. The amount of reduction makes it inadvisable to show them here.

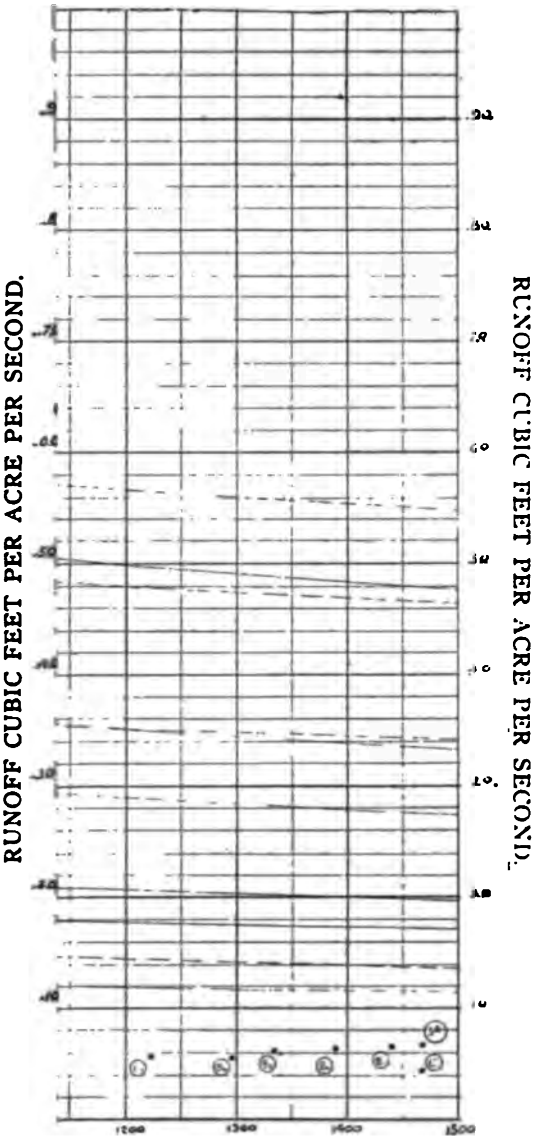
The Meadow street (M_1, M_2) outlet, we see from the plate, serves an area of 668 acres, mostly well built up. It lies on the diagram between the Hawksley-Bazalgette and Burkli-Ziegler curve for suburban areas. Its theoretical maximum would be reached at .687 cubic feet per acre per second, which would make it lie slightly above the New York curve for completely built up areas.

The East street (E) outlet serves an area of 1,469 acres and lies below the Hawksley-Bazalgette curve. Its theoretical maximum would be reached at .442 cubic feet per acre per second, which would make it lie just below the New York curve for well built up areas. It is relieved, however, by the overflows at Greene street, Grand avenue, Humphrey street, Canner street and Rock Lane, which added would cause it lie about on the Burkli-Ziegler curve for built up areas.

The James street (95) also lies below the Hawksley-Bazalgette; it serves an area of 275 acres. Its theoretical maximum would occur at .639 cubic feet per acre per second, which would make it lie between New York curve for well built up areas and McMath for built up areas. Relief is afforded it by the overflows at Grand avenue and State street. These added would cause it to lie about on the New York curve for suburban areas.

The Poplar street (102) serves an area of 424 acres and lies on the Hawksley-Bazalgette curve. Theoretically its maximum would occur with .399 cubic feet per acre per second, which brings it between the Burkli-Ziegler curve for average city areas and the New York curve for suburban areas. It is relieved by the overflows at Grand avenue and Lombard streets. The addition of these would make it lie between the Burkli-Ziegler curve for built up areas and the New York curve for well built up areas.

The Boulevard (B) likewise lies below the Hawksley-Bazalgette curve. It serves an area of 1,440 acres. Its theoretical maximum would occur at .242 cubic feet per acre per second, which would cause it to lie between the McMath curve for suburban areas and the Burkli-Ziegler curve for average city areas. It is relieved by overflows at Congress and Derby avenues, which added would cause it to lie between the New York curves for suburban and well built up areas.



.UNOFF FORMULAS.

We see, then, that the Boulevard, East, James and Poplar streets outlets are performing their work in a fairly efficient manner. There are, it is true, certain subdivisions of all four, from which occasional complaints are received. It would be interesting to take up these in detail and investigate them, but the limits of this paper will not permit. None of these districts as yet has reached the point where their proportion of impervious area preponderates. Their location is such, adjoining natural water ways, that when that time comes relief can be easily afforded them. We may therefore say that their efficiency is good.

The remaining outlet, the Meadow street, with 56 per cent. of its area impervious, and increasing rapidly, in the future presents a condition which is not reassuring.

The duration of the storm which will cause a maximum discharge being comparatively short, its lower levels are running full relatively early in the storm. It contains most of the old sewers constructed prior to the design of the present system, and, which we see from Plate IV, are inadequate to perform the work which they now have to do. Its location does not admit relief being easily afforded in its higher levels, and if relief outlets be constructed at its lower confines it is questionable if the results desired will be obtained.

To follow up its various subdivisions, to study them in their relations to the work which they have to perform, would so extend this paper, which already has exceeded its original limits, as to make it inexpedient at this time. We may conclude, however, that if our assumptions in the beginning of the paper are true, that its efficiency is very poor.

We may state further, that in the designing of sewerage systems, the Hawksley-Bazalgette and the Adams formulas have had their day. Both are based on a rate of an inch of rain an hour, and the occurrence of this rate at rare intervals. This we now know not to be so, but that it may occur as frequently as three or four times a year.

No formula may be applied indiscriminately, but each district should be carefully compared, in all its features, with some similar one, the results from which have been noted and studied, and a formula evolved and applied which will give the best results in the light of previous experience and practice.

EXPERIMENTS MADE IN AUSTRIA-HUNGARY, ITALY AND SWITZERLAND TO PREVENT THE FORMATION OF HAIL BY MEANS OF CANNONADING.

By Theodore Wirth, Superintendent of Public Parks, Hartford, Conn.

For the last few years there have appeared in European newspapers and agricultural publications occasional reports about experiments made, first on a small and then on a larger scale, to prevent the formation of hail by means of heavy shooting; and while in Switzerland this past fall I had occasion to inquire into the results of these experiments and to gather some information and printed reports, the perusal of which proved very interesting.

The belief that human ingenuity would be able to interfere with the creating capacities of destructive elements was shared by few, and ridiculed not only by the public in general but even by scientists of high standing. Nevertheless, it is a proven fact that such a belief already existed centuries ago, for there are many old church bells in existence to-day which bear the inscription, "Fulgura frango" ("I scatter storm"), and the ringing of those bells, producing sound-waves, was credited with the power of preventing the formation of hailstorms.

The celebrated astronomer Arago reports that already in 1680 cannons were used to dispel hailstorms, and a century or so later a French marine officer, the Marquis de Chevriers, cannonaded approaching storms, as he was convinced from experiments made while in active service that cannonading would dispel storms and hail. He therefore kept some cannons for weather shooting on his estate in Maconnais, and after his death the people of that community kept it up, evidently believing in the effectiveness of the work, and in 1806 there were more than a dozen towns in that vicinity that followed his example.

The origin of hail is still obscure, but the scientists seem to agree that same is formed by certain sudden and intense atmospheric changes of temperature and through the existence of certain electrical conditions. It has been observed by all who have made this subject a study that seemingly a very strong local accumulation of electricity takes place previous to a hailstorm, which is discharged during the storm, but immediately before the hail begins to fall there is always a certain dull calm in the air, which broods danger. This apparent stillness of the atmosphere represents, according to the latest scientific findings, the epoch of hail formation. It is claimed that the crystallization of the damp atmosphere can only take place during a period of absolute calmness in the air. This seems to have been fully demonstrated through an experiment made by Professor Dr. Kreuschner in Darmstadt. He arranged two pole wires of a strong electrical current so that one entered a basin of water from below, reaching within near the surface of the water, while the other was brought from above near said surface, without, however, touching same. Upon application of a strong current, which in order to complete the circuit had to span the short circuit, the water surface between the two wires' ends began to recede, forming a small funnel, out of which first small drops of water and after a short time small hailstones were thrown with great force. The least disturbance of the air, however, the moving of a hand or even heavy breathing, would at once stop the process of crystallization, and in place of hailstones he got raindrops. Similar conditions, it is claimed, exist a few minutes before the breaking of a hailstorm, only with the difference that the water is not below, but above, and that same is not present as a fluid, but as a vapor in a condition very close to condensation.

Assuming that these theories are correct, it becomes at once evident that to disturb the calmness of the air preceding the breaking of a storm means the prevention of the process of crystallization, the formation of hail, and this seems to have been accomplished quite successfully in several localities through cannonading with cannons especially constructed for this purpose. The honor to have modernized the old style of weather shooting, bringing it to the present state of usefulness and efficiency, belongs to Mr. Albert Stiger, mayor of the small town of Windisch-Feistritz in Austria. The town is located between hills the slopes of which are exclusively covered with vineyards, which represent the prosperity of the farming population in that vicinity. For years and years in succession this locality was visited by periodical hailstorms, which often destroyed everything. The good mayor set to work and succeeded in establishing a system of hail weather protection, which kept the territory over which he distributed his artillery free from hail for five years in succession, while the surrounding unprotected territory was visited as formerly by regular hailstorms. It seems that his fellow citizens thought him a fit subject for an asylum for the insane when he first started to introduce his artillery, and later on neighbors outside the protected district wanted to sue him for driving all the hail over the line into their vineyards.

[illegible] started his experiments about 1895, and since then [illegible] localities in Austria- [illegible] especially where vine culture [illegible] results have been more [illegible] that each locality [illegible] must be studied. [illegible] cultivated lands [illegible] population against [illegible] is clearly a [illegible] of the people [illegible] experiments of [illegible] that one cannon alone will not be effective, but that there must be a number of stations of one cannon each established over a large territory, and they must be well served under a systematic and practical management, for it requires united action at the proper time to achieve the desired results. The cost for one cannon, with complete outfit, including building, is about 400 francs ($80).

It is interesting to compare the cost of insurance against hail damage with the cost of protection. A farmer in a district known to be apt to be visited by hailstorms has to pay from 40 to 70 francs ($8 to $14) on 1,000 francs ($200) hail insurance, while the cost of protection against hail by the herein described methods will not average more than 5 francs ($1).

In order to give this subject the attention which it seemingly deserves, it would require a much more exhaustive and detailed description than herein given. While the experiments have been generally successful, the matter must still be considered to be in an experimental stage, but the theories upon which they are based and the favorable results obtained seem to be of sufficient value to attract the attention of authorities and individuals interested in agricultural and horticultural pursuits. I, for one, would like to see the national government use part of the money wasted on free seed distribution on such experiments. We have right here in the Connecticut valley large risks in the tobacco culture, which would warrant them to be made on an extensive scale.

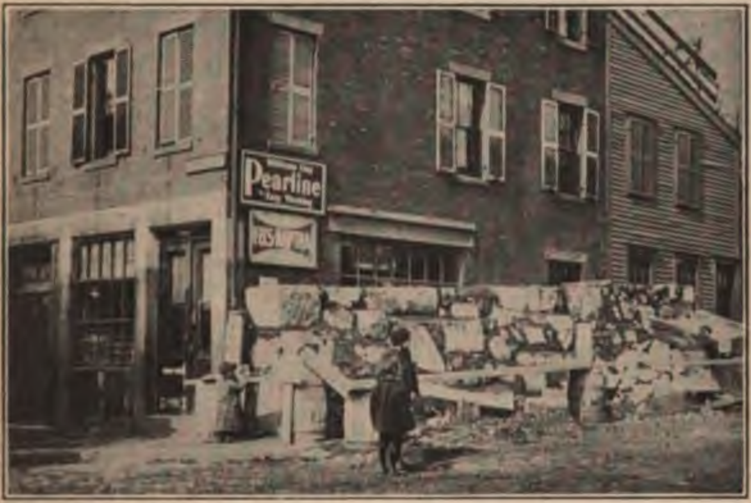
THE "BOSTON & PROVIDENCE EXTENSION" IN BOSTON.

[illegible]

[illegible] at the inter[illegible] street necessitated [illegible] for which [illegible] the entrance of the [illegible] Haven and Hart[illegible] of opera[illegible]

[illegible]

were further complicated by the fact that the approaches to the Boston & Albany bridges from the south were on ascending grades which could not be increased. As the new bridges were to have the same elevation as the old, this necessitated a new grade, parallel to the old approach, but some seventy-five feet further south, with a resultant lift of street surface ranging from a maximum of nearly seven feet at the upper end of Albany street, to but a few inches on Shawmut avenue, and running out to zero at the further end where the old surface was joined; necessitated also corresponding changes in the multitude of underground pipes and conduits; in the entire drainage system; and by no means least, in the fronts of the houses abutting upon the disturbed area. And finally, for practically the entire distance the location lay through an old salt marsh, but comparatively recently brought to street surface by some fifteen feet of typical "filling," in which settlement had by no means ceased.



Northwest Corner of Albany and Seneca Streets showing Retaining Wall to Protect Buildings. The New Street Grade is the Top of the Wall.

The work was planned by, and executed under the direction of, the engineering department of the New York, New Haven and Hartford Railroad, Mr. Fayette S. Curtis (since second

Vice President), Chief Engineer. The broad outlines only of the scheme had been determined upon, when in the late fall of 1897 Mr. R. M. Berriam, Assistant Engineer of Construction, was placed in charge.

ORGANIZATION AND PRELIMINARY WORK.

The organization was developed as the progress of the work demanded, consisting, as completed, of a principal assistant, Mr. Edwin J. Beugler; a chief draftsman, Mr. R. C. Meggy; two second assistants, Mr. Arthur P. Law, in charge of the Fort Point channel bridge, and the writer, in charge of the extension proper; and inspectors, transitmen, draftsmen, etc., as required.

The limited area affected brought the work directly under the eye of the engineer-in-charge, who personally inspected the progress at least once daily; detailed reports from the inspectors furnished data for progress records, which were checked by the monthly estimate; while a diary supplemented by a large series of photographs recorded all matters of interest.

Certain reasons made desirable three lines of reference.

The south limit line of location was the datum for the deeds of taking and for the retaining wall; the centre line of location was important only in its legal aspect. The line of division between the Boston & Albany and the extension, the "Limit Line of Construction," always referred to—except officially—as the "L. C.," was by far the most important, to it being referred all the construction and, for all but legal matters, the land and building lines.

As a preliminary, the L. C. was run out,—so far as possible directly, or if not so, by offset—on the ground; every station was referenced by a right-angled offset to the Boston & Albany retaining wall; and points of curve, intersection and tangency were referenced by two tie measurements in addition to the rectangular offset. All of the reference points were marked with white paint and chisel cuts, and the various distances were painted beneath.

With this line as a base detail surveys were then made, locating not merely the track, wall, property, and street lines, but the windows, doors, steps and areaways of houses affected by the grade changes; all manholes, catch basins, valves and junction boxes; and the sewers, pipes, and conduits connected with them. This later information was checked by the records of the various companies, most of which had fairly complete data concerning their own structures.

Elevations were based upon Boston city datum as given by various benches of the street and sewer departments, a chain of levels being carried up one side of the location and back on the other, on the street grade, and a third line run through on the track level. The facilities for cross checking made it possible to reduce the closure error to a minimum; the loop closed with an error of but 3/100 foot for a distance a trifle over two miles.

As the cramped nature of the work made it important that there be no unnecessary delays, every turn was made a bench; during the progress of construction these were frequently checked with one another and with other benches to detect any displacement. Tables giving the location, description and elevation of each bench, together with track and wall grades, track alignment, and L. C. alignment and references, were then made up, and a copy pasted in every field book issued.

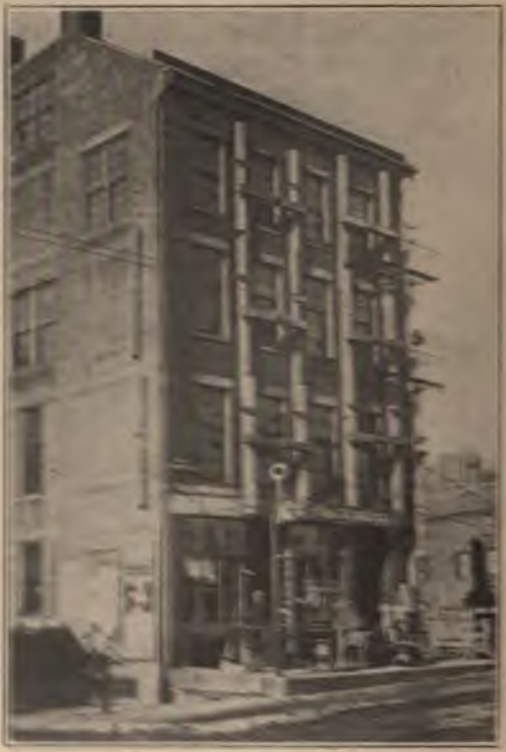
WORK ON BUILDINGS.

While the preliminary surveys were under way, active construction began with the removal of the houses within the area of taking. In the majority of cases the buildings had been purchased outright, but a few remained where no agreement had been reached regarding the portion lying without the south line of location, and which for that reason did not come within the scope of the powers of condemnation conferred upon the railroad.

One miserable shell at the corner of Harrison avenue and Motte street was almost hidden by the bracing and tie rodding necessary to keep it from falling in pieces after the taken portion had been removed. Condemnation by the Boston Elevated for its overhead structure solved the problem of what to do to the remnant.

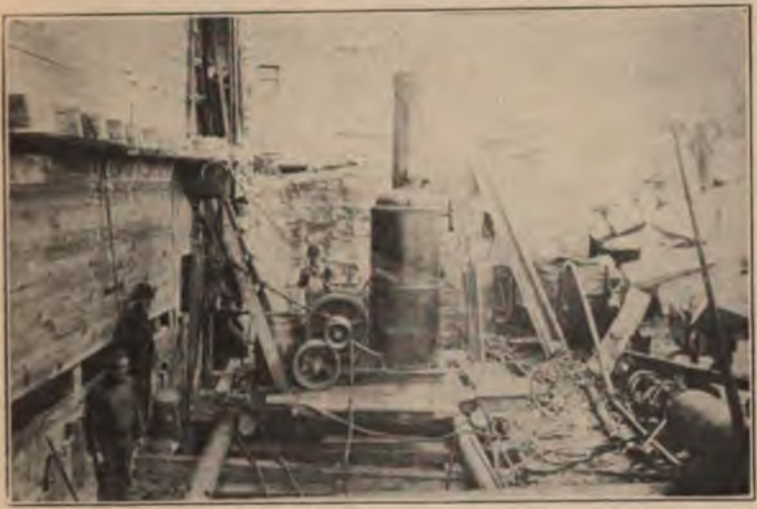
At the corner of Columbus avenue and Cazenove street the line cut through a comparatively new apartment house, the

"Glendon." The owners refused to permit the removal of a portion of the floor so a pile driver could be used to drive the necessary foundation piling, while the nature of the soil made it unwise to attempt to carry the walls on the retaining wall foundations by a cantilever system.



SPECIAL BRACING, NORTHWEST CORNER OF HARRISON AVENUE AND MOTTE STREET. ONE-HALF OF BUILDING HAS BEEN REMOVED.

Under these circumstances was designed what is probably the smallest pile-driver ever used. The hammer and engine were of normal size, but the leaders were not quite eight feet long over all. Piles were cut in lengths of from eight to ten feet. The first section was driven in a trench four or five feet deep, the head being protected by an oak cap. When flush with the surface a second section, having a wrought iron ferrule eighteen inches long and dowel pin of one and one-half inch gas pipe, was fitted on, and in turn driven. In some cases four-section piles were used. It was found that the earth displaced by a pile had a tendency to open the joints of the piles already driven. Accordingly, about twenty-four hours after driving, the foundation was again gone over and each pile tapped home. Careful tests extending over considerable time showed that these sectional piles were practically as effective as solid sticks under the same conditions of driving and soil, and they were used in a number of other instances.



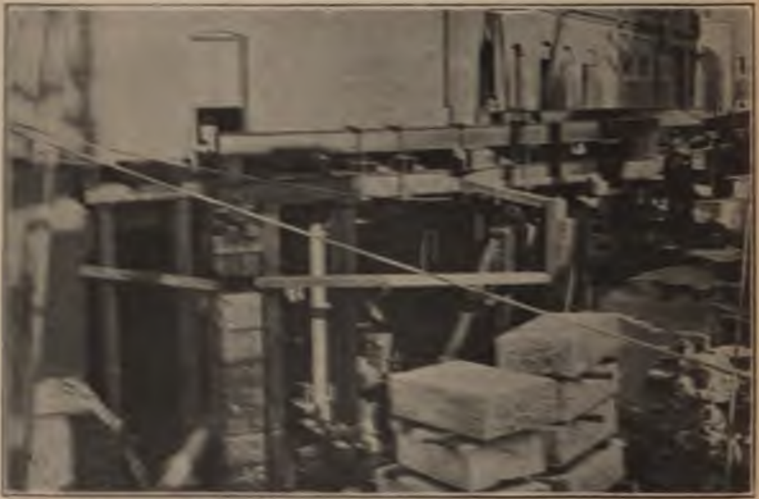
Even the "runt" driver was unable to reach one point in the Glendon foundation, directly under a heavy wall corner. Here pile clusters were driven either side, designed for the same load per pile as the rest of the foundation; a granite arch of fourteen feet span was sprung across, resting on a steel beam and concrete grillage on the clusters; and the gap closed by a brick curtain wall.

Immediately across Columbus avenue from the Glendon stood the Edinburg, a large six-story brick apartment, in plan the quadrilateral formed by cutting off one end of a forty-five degree right triangle. The base, along the Boston & Albany tracks, is one hundred and thirty feet; the altitude, ninety feet.

The location passed directly through it, and it was purchased with the expectation of tearing it down; later it was decided to support it on a steel frame and carry the tracks beneath.

As a preliminary, a careful investigation was made of its condition, and tie rods were set up at possible points of weakness.

The plan called for two piers and an abutment; the outer pier lying outside the building; the other pier and the abutment within. The construction of the outer pier, brick with granite belt and cap courses, carried on a grillage on piles, was in no way unusual except that the piles were driven along the building first, to protect the foundations from possible uplift from earth displaced by the piling.



False Work Under Corner of Edinburg. The Middle Pier is Just Left of the Centre of the Picture; the Cut Stone at the Right is on the Abutment.

For the centre pier and the abutment heavy wooden horses were erected on each side of the brick walls to be cut through and on each side of the proposed opening, and cross beams set inside and out; holes were made through the wall; needle beams placed and wedged up; and the material below could then be safely removed.

As the work progressed, it was found that although apparently well built, the brick-work had been badly scamped; considerable portions of the walls were apparently held together only by the pointing and "Force of habit." For this reason it was particularly important that the false work be extremely rigid, and that there be as little changing of supports as possible; and the combinations of cantilevers, girders, half girders, and needle beams employed were very ingenious and equally successful.

While the design of the false work was under the direct supervision of the engineer, and was in all cases checked before use, the credit is due the contractor, Mr. John Soley, whose ingenuity found a way out of every difficulty.

The foundations were driven with a runt driver, but the depth of cut-off and the height of the basement ceiling permitted the use of single stick piling. At two points, where the driver was unable to reach, the gaps were spanned by steel beam grillages on pile clusters, as in the Glendon.

As soon as the masonry was completed the steel work was placed, and as fast as connected up, the loading was transferred to the new system. It had been feared that there might be unequal settlements in spite of the care taken with the foundations. To correct any such trouble the main floor system rested upon longitudinal box girders, beneath which were pockets into which jacks could be slipped. These pockets were spaced to give an approximately uniform load per jack in case it should be necessary to raise the entire floor. As a matter of fact, no wedging up has been required, the settlement, if any, being uniform.

The supporting system is designed to carry a load of about 4,000 tons, giving a foundation load of five tons per pile.

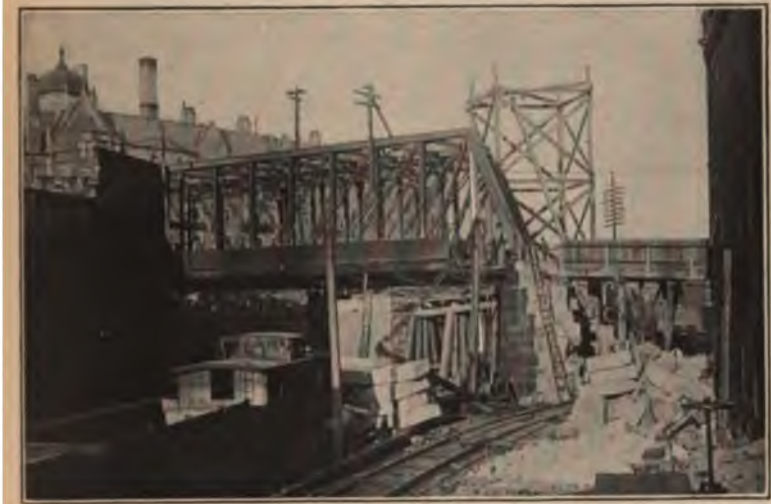
On the completion of the steel work it was protected by a coat of concrete on expanded metal, which was also sprung between the beams to form a floor, the latter designed to carry a distributed load of five hundred pounds per foot, or a fifteen ton road roller.

On the same side of Columbus avenue as the Edinburg, and just across Buckingham street, is a row of three-story apartment houses, two of which had been purchased to be torn down in widening the approach to the Back Bay station. Changes in the plans made it necessary to remove but one, and as the entire block leaned to the north—the end building was fourteen inches out of plumb in forty feet—it was decided to buttress what had been the party wall, and was now the end wall. Owing to the general shakiness of the locality, piles could not be safely employed in the foundation of the wall built to relieve the house wall of the thrust of the filling, and the footing courses had been spread according. The buttresses, four in number, each with granite ties passing completely through buttress and house wall at each flooring and with alternate courses of brick bonded into the old work, sprang from this retaining wall. Great care was taken to secure perfect bonding and freedom from shrinkage, with perfect success, as was shown a little later, when the retaining wall settled, leaving the buttresses hanging from the wall they were designed to support. At first steel wedges were used to take up the weight; later, as it was found that the house wall was amply strong, and did not settle, the crack was filled with mortar from time to time.

Bridge and Wall Work.

Not only was it necessary to build new bridges at every street crossed but one, but the old bridges had also to be supported while alterations were made and the old abutment was replaced by a pier.

At Dartmouth street a three-truss Pratt bridge of 165 feet span and a plate girder of about 35 feet span carried the street across the old Providence division and the Boston & Albany tracks. It was necessary to move this bridge bodily endways 33 feet 8 inches. The new pier was first built, up to and including the bridge seat, and the necessary alterations were made in the west abutment. Very heavy wooden trestles were next erected between the old and new work at each end, and the short plate girder span removed, a false floor being left to carry traffic. Meanwhile a strut 12 inches × 12 inches, with a casting at the upper end to fit the pin, had been placed at each intersection of portal and truss. The lower half of the compound pedestals had been removed, a sled built up of four twelve-inch I beams, reaching from the pedestal to the strut, which passed through it, had been placed in position, the upper half of the pedestal resting on the sled, and three-inch steel rolls had been placed between the sleds and runways of old rail on the falsework. When all was ready the bridge was closed to traffic; sixty ton jacks were placed one under each outside truss strut, and one hundred ton jacks under each mid-truss strut; the bridge was lifted until just free, when the strut was fastened rigidly to the sled by lugs and wedges, and the bridge was lowered back upon the rollers, and immediately drawn to its new position. The actual time of moving was fifteen minutes. The street was closed to teams two weeks; to foot passengers it was closed but one day.



Southeast End of Dartmouth Street Bridge, Just Before Moving. The Lifting Strut is Directly Behind the Mast of the Derrick, but the Jack can be Seen Close to the Ground.

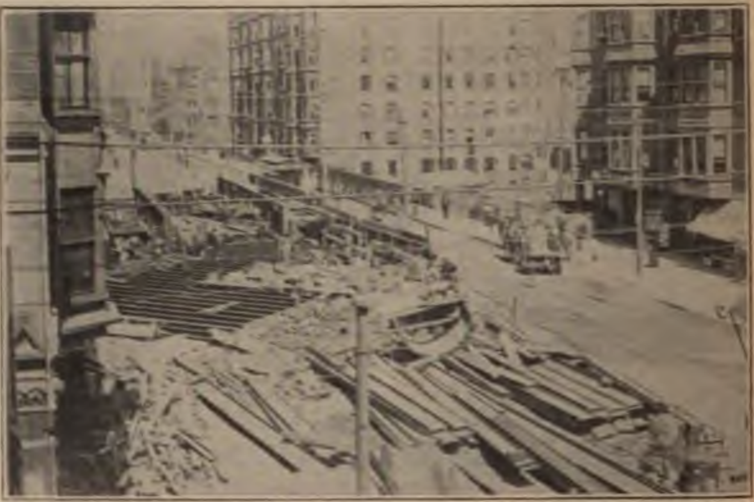
At Tremont street the old bridge was to be lengthened. The old abutment being of an unusually fine grade of masonry it was decided to cut off the back, leaving about two feet of the front to act as temporary pier, rather than build false work which would seriously interfere with the Boston & Albany R. R. train movements.

The work was successfully done, although the cramped quarters added greatly to the difficulties of cutting through what was practically a monolith.

At the other bridges, where more space was available, a heavy timber bent was erected to carry the bridge while the abutment was replaced by a pier.

NEW BRIDGES.

As before mentioned, the importance of the streets crossed made it necessary to maintain traffic during construction. The same general procedure was followed in each case. A fence was first erected along the middle of the street from the old bridge to beyond the area of change, and was carried to the street line at each end of one-half, leaving the other half open for traffic. In the fenced-off area piles were driven in bents parallel to the line of the extension, one bent just inside the new pier, one just in front of the new abutment, and others located between according to conditions.



COLUMBUS AVENUE BRIDGE SHOWING WEST SIDE UNDER CONSTRUCTION, AND TRAFFIC ON TEMPORARY BRIDGE ON EAST SIDE.

These bents were then capped, stringers placed, and a temporary bridge floor built at or above the new grade, carrying one line of electric car tracks. As soon as ready, traffic was turned upon it, and the other half shut off. It was then possible to complete one-half the bridge, and to bring the masonry of the other half up to the floor system of the false work. The bridges, with the exception noted later, were built with longitudinal floor girders; it was thus possible to complete one-half without reference to the other. The street changes were made at the same time for that half; traffic was then shifted to the new grade and the work completed.

At Washington street, however, the limited headroom necessitated cross floor girders, which were carried by heavy girders either side of the roadway. By careful work it was possible to build enough masonry to carry these and the sidewalk girders without seriously undermining the roadway, a temporary trestle meanwhile carrying the foot passengers.

The girders were next set and the sidewalks planked, the pair opposite the temporary work going in first, traffic then being turned on it while the other side was erected. When everything possible had been done, the street was closed to teams and the work rushed to completion. This street was closed ten days to teams; for no period was it closed to pedestrians.

RETAINING WALL.

As soon as the demolition of houses had proceeded to a sufficiently advanced stage, work was begun on the retaining wall.

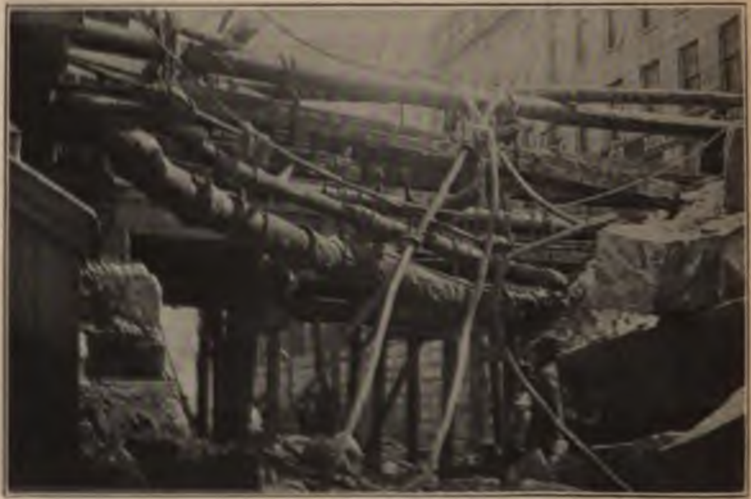
To prevent possible slips, the wall was built before any of the material in front was removed. A trench of width inside bracing about three feet greater than the wall foundation at that point, was carried eighteen inches below pile cut-off, the sides being heavily braced. The presence of many pipes and conduits necessitated great care. They were usually hung in chains from beams independent of the trench-work. As rapidly as possible the new lines were constructed, but in some cases the old lines remained after the completion of the masonry.

In a few localities it was possible to employ the ordinary form of pile drivers; for most of the work, however, the driver runs were from fifteen to twenty-five feet above pile cut-off. For this work an extension leader driver was devised, which steadied the pile to the bottom. For driving the battered front row special machines were used. Local conditions made it desirable to build these in two types, one driving under, the other, outward.

As soon as the masonry was completed, the sheeting was withdrawn and the wall backfilled; the material in front was then excavated by steam shovels, and taken out on cars.

STREET CHANGES.

The same general plan was followed in all the street work. The grade line for the back of the sidewalk was marked on the fronts of the houses; temporary exits and entrances were arranged; a retaining wall with top at level of back of walk was built at the house line; a dry rubble wall was built down the centre of the street to retain the fill until the other half was completed; curbs, coal holes, manholes, area-ways, hydrants, valves, etc., were raised to the proper height; the fill was then made, and the new sidewalk and street surface laid. Whenever possible this was done in conjunction with the bridge work, one-half the street being completed at a time. In a few instances of narrow streets the entire area was brought to grade in thin layers, the street traffic going on for the time over a dirt road. Only in the case of one or two unimportant cross streets, and



PIPES AND CONDUITS ON THE WEST SIDE OF HARRISON AVENUE. THERE ARE TWO LARGE PIPES OUT OF SIGHT UNDER THE TEMPORARY BRIDGE (IN THE BACKGROUND) AND NEARLY AS MANY MORE PIPES AND CONDUITS AS SHOWN ON THE OTHER SIDE.

one street parallel to and heavily cut into by the work, was it necessary to close the street completely.

Pipes and Conduits.

For the most part the various pipes and conduit changes were important only because of their great number. At Tremont street, however, a pair of thirty-inch water mains required quite a little attention.

At this point the extension, sweeping to the right by a long curve, cuts deep into Castle Square, as is called the area formed by the intersection of Castle, Ferdinand, Chandler, and Tremont streets. By the terms of the Extension Act, the railroad was to restore the square to its original area, and for this purpose a floor of steel beams, spanned with brick jack-arches, and filled with concrete, was to be used.

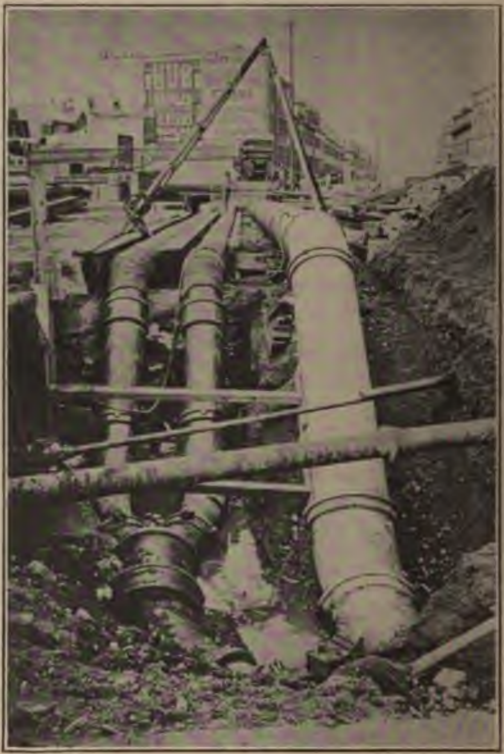
The twin main in question rose to the surface just west of Tremont street, crossed the tracks of the Boston & Albany on a plate girder bridge parallel to the street bridge, and dropped back into the earth just inside the Boston & Albany south wall.

Under the original plan the entire main was to be moved well to the eastward, to cross both sets of tracks on a bridge of its own. Meanwhile a temporary trestle had been built at the level of the pipe bridge; on this the mains were extended to a new connection with the old line just back of the new wall, the demand upon them being such that either one could be cut out for some little time without serious effects.

The steel floor was completed to this trestle, when changes in the plans of the Elevated Railway rendered it advisable to carry the twin mains across in their original location.

The pipe line axis crossed the floor beams, which are radial to the curve, at an angle of about thirty degrees; it was decided to use a series of twenty-four-inch I beams parallel to the pipe line; to connect the cutoff smaller beams to the outside beams of the series; and to carry the mains, reduced to several smaller mains, in the channels thus formed. As the mains were not likely to be taxed to their full capacity, two twenty-inch steel pipes were used for each thirty-inch main.

As soon as the permanent work was sufficiently advanced, the two mains were slung in chains from an overhead system resting upon the new piers and abutment, and the trestle was removed. It was then possible to place two outside and the middle of the twenty-four-inch beams. When the outside beams had been riveted to the floor system, the middle beam was braced against the east side girder; a two-inch floor was laid upon the inside flanges of the west and middle beams; runways were slipped under the west main, which was then disconnected; and the joints being broken, the sections were hauled endways out of the tunnel formed by the beams and the overhead system. As at this time the tracks of the extension were in regular service, all work had to be done on the upper level, and great care taken that nothing fell through to the tracks.



Castle Square Water Piping; West Main in Permanent Condition; East Main Ready to be Changed.

The intermediate beam was then placed and the expanded metal and concrete protection put on. The limited clearance—fifteen feet from rail to bottom of bridge—precluded the use of any protection. In spite of heavy loading above, the exhaust from the engines cut through the green concrete. It was finally necessary to have all trains coast past this section for several days. After the concrete had set there was no more trouble.

The twenty-inch steel pipes covered with a coat of felt boiled in resin and oil, to prevent freezing in winter, were carried in steel slings shaped to fit the pipe; after being connected, and standing under pressure several days to detect any leaks, they were covered by ¾-inch thick steel plates bolted to the top flanges of the heavy beams.

BACK BAY STATION STEEL WORK, FROM BENEATH THE EDINBURG.

The placing of the second set was greatly simplified by the removal of the overhead supports, and the convenient platform made by the cover plates of the west half.

The old bridge across the Boston & Albany tracks was replaced by a new structure at the same time. The new span was designed a little wider than the old, so the girders could be placed without interference from the latter; the pipe line was then hung from beams supported by the new girders, after which the old structure was readily removed.

BACK BAY STATION.

While of great interest on many other accounts, there was little out of the ordinary in the construction of the Back Bay station. The majority of the one hundred and twenty-two column piers had their centres on lines normal to Buckingham street; the others were on lines parallel to Dartmouth street. A base line was accordingly laid down on Buckingham street, on the east sidewalk thirty-five feet from the face of the building, and heavy oak bolts, their tops flush with the walk, were driven at the intersection of this and each column line, and centred. A similar set of stakes was set about ten feet from the face of the building along the Boston & Albany tracks, and tables were drawn up showing the distance of every column from these base lines, measured on the lines established. It [illegible]

[illegible]

[illegible] track work was [illegible] until its completion [illegible] working hours [illegible] the work.

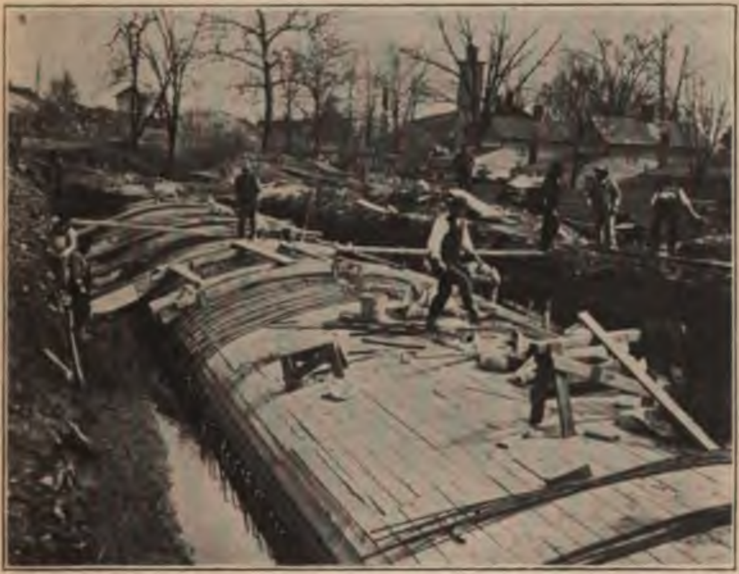
[illegible] track lies between two [illegible] was necessary to pro- [illegible] hundred thousand gallons [illegible] prevented the discharge [illegible]

[illegible] feet wide by [illegible] eight feet deep; [illegible] with brick jack [illegible] high [illegible] grounds, and [illegible] made [illegible] failure of the [illegible] had fully [illegible]

STEEL-CONCRETE ARCH.

By A. William Sperry.

The Bristol & Plainville Tramway Company wanted to build a car barn, but the area of land was not sufficient unless the building could be extended over the raceway which crossed the property.



FORMS AND CENTERS.

Several plans were worked out,—

1. I-beams resting upon supporting walls on each side of the raceway.
2. Reinforced steel concrete floors.
3. Steel concrete girder and floor.
4. Steel concrete arch.

It was necessary that the structure adopted should occupy as little headroom as possible. The plan that seemed to meet the existing conditions the best and for the most reasonable expenditure was the arch. The approach to and across the front of the building is on a 3 per cent. grade, this being necessary in order to get above the water level in the raceway.

The building is 96 feet wide, making a grade across the front of 2.9 feet. It is divided through the center by a fire wall. The floor on one side is 1½ feet above the floor on the other in order to accommodate them to the difference in grade. The roof is of mill construction with a three-ply felt and gravel covering. It is supported at the sides on the walls 46 feet apart and at the center by columns spaced 10 feet center to center. These columns rest on the crown of the arch. On each side of the columns is a line of trolley tracks. The accompanying plan shows the measurements and location of loads.

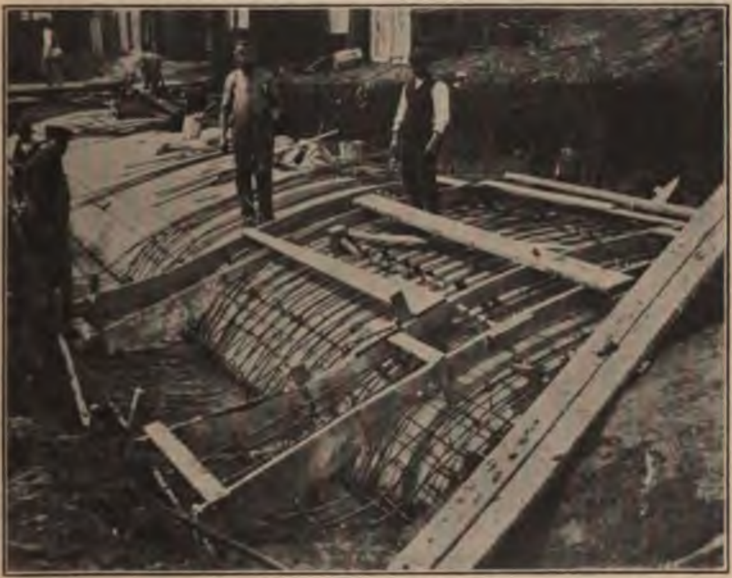
SITE OF CAR BARN.

The arch is composed of concrete and round steel rods; the concrete was mixed in the proportion of about one part of Portland cement to 2½ parts of sand and 5 parts of ¾-inch broken stone and mixed rather wet. All the false work was erected before any concrete was placed.

The arch is 190 feet long, 140 feet of which is covered by the building; the span is 17 feet 8 inches, depth at center 4 inches, on ribs 9 inches.

The safe loads, with factor of four, used were: Roof load on columns 10 feet center to center, 12,000 pounds each; track car wheel load on each 6 feet of rail, 4,000 pounds each.

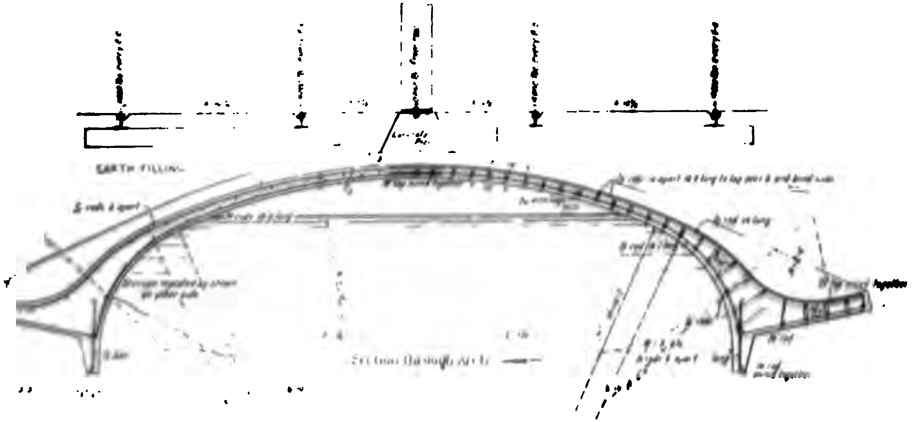
The cost, complete, including excavation and false work, was $2,750.



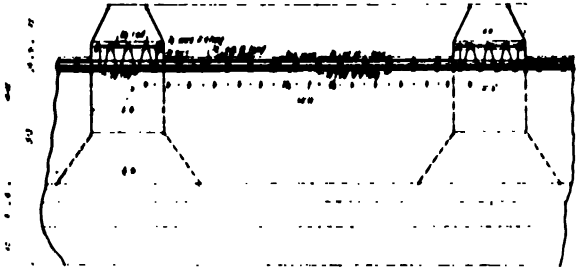
STEEL REINFORCEMENT.

The Steel Concrete Construction Company, of Baltimore, Md., were the contractors. Owing to the water and earth embankments, it was a difficult piece of work to execute, but it was handled in a workmanlike manner and completed satisfactorily.

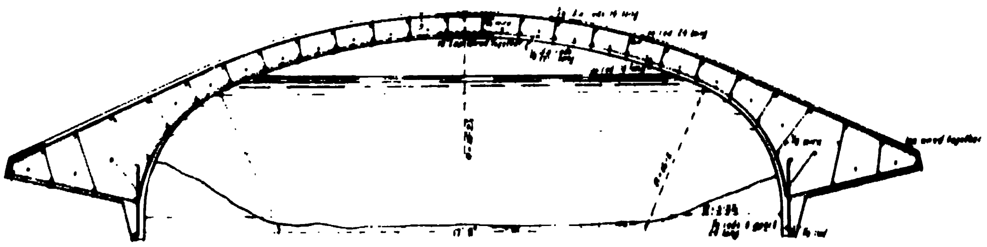
It was impossible to make tests to show the deflections under loads after completion, although accurate levels have been taken from time to time under varying conditions. With both tracks loaded full with cars and the roof covered with 11 inches of wet snow, the deflections at the various columns vary from .008 of a foot maximum to .004 of a foot minimum.



Section through Arch



Longitudinal Section



Section through Rib

PLANS FOR
STEEL-CONCRETE ARCH
through the [illegible] of
THE BRISTOL AND PLAINVILLE TRAMWAY Co
BRISTOL, CONN.
January, — 1898

A William Sperry, Civil Engineer
New Haven Conn

George H. Wilson, Del.

TELEPHONE ENGINEERING.

By Edward H. Everit.

One of the first telephone exchanges in the world was opened in New Haven on February 21, 1878, with fifty subscribers, and shortly after, a report was made to the board of directors of the company, stating that they might expect "as many as 200 telephones in the city." A similar estimate, made up a year or two after, placed the ultimate for the State at 5,000 stations. Since that time experience has shown that the number of telephones in any district is directly proportional to the number of inhabitants of the same district, and that all estimates of telephones should be based on that fact.

On January 1, 1901, the number of telephones per 100 population in cities of the United States having total population of 50,000 or over was 2.21. On January 1, 1902, this had increased to 2.85; on January 1, 1903, to 3.56, and on January 1, 1904, to 4.19. The number of lines per 100 telephones on January 1, 1901, was 63.8, on January 1, 1902, 57.2, on January 1, 1903, 53.4, and on January 1, 1904, 50.6. On January 1, 1901, 68.8 per cent. of the total number of telephones in the cities of over 50,000 population were at business stations, and 31.2 per cent. were at residences. On January 1, 1902, 65 per cent. were business and 35 per cent. residence. On January 1, 1903, 63.5 per cent. were business and 36.5 per cent. residence. On January 1, 1904, 61.1 per cent. were business and 38.9 per cent. residence.

The above figures are intended to give an idea of the steady growth of the telephone business and also to call attention to the fact that the telephone development has increased from 2.21 telephones per 100 population on January 1, 1901, to 4.19 on January 1, 1904. Also that the number of subscribers' lines per 100 telephones has decreased during the same time from 63.8 per cent. to 50.6 per cent., and still further, that the residence stations have increased from 31.2 per cent. to 38.9 per cent., showing that the telephone has long since outgrown the luxury stage and has become an absolute necessity. Experience has shown also that the residence telephones are much more generally on party lines than are the business telephones, which indicates that for the more important classes of service the single party line is the more desirable.

On January 1, 1904, the greatest development in the United States was in Seattle, Wash., where the number of telephones per 100 population was 13.6. In Portland, Ore., it was 12.1, in San Francisco, Calif., 11.4, and in Los Angeles, Calif., 11. The telephone development in New Haven, Conn., on January 1, 1901, was 2.9, on January 1, 1902, 3.2, on January 1, 1903, 3.4, and on January 1, 1904, 4.3. This is a fair example of the development in the eastern cities.

If we assume that the cities along the Pacific coast are approaching the highest development that can be expected in that region, and assume the same development in cities like New Haven, Hartford, etc., it will readily be seen that provision must be made for an enormous increase in the business. In Seattle, the percentage of business telephones to the total is 34, and in New Haven the percentage is 62. Assuming that Seattle is an indication of what may be expected in the future, the greatest growth in New Haven will be in the residential districts and this holds true for the whole State. This is still further confirmed by the figures given in the first part of this article, which show that the ratio between business and residence telephones has changed from 68.8 per cent. business and 31.2 per cent. residence in 1901 to 61.1 per cent. business and 38.9 per cent. residence in 1904. As a matter of fact, the contracts now taken for new service also show that this theory is correct.

Although it appears from the figures given above that at the present time the number of telephones per line is increasing, due, as stated, to the greater proportionate increase in residence telephones on party wire service, it is realized that since the best service is that obtained with the single party wire, and the demand for the best is sure to follow, all plans for handling the business at an ultimate period must be made up on the assumption that the percentage of lines to telephones will be very much greater than at present, that is, there will be more single party subscribers, and, therefore, more lines per 100 telephones, than at present, and provision must be made for these additional lines in an ultimate study of a city.

The first telephone system was made up by connecting two telephone instruments together by means of a single wire circuit, each end of the circuit being connected to the earth. Other instruments were connected to the first circuit until it became necessary to sub-divide it into groups, each group having its own circuit. In order to provide for communication from an instrument in one of these groups to an instrument in one of the other groups, it next became necessary to install some apparatus for connecting one of the circuits, with its group of subscribers, to any other circuit. This apparatus was christened a switch and was the forerunner of the modern switchboard. "Instruments" became "subscribers" and an "exchange" was opened.

The growth of such a system to moderate proportions was a very easy matter to take care of, and it required no extraordinary ability on the part of those who undertook the engineering to handle it. It was simply a matter of reaching the subscriber's house with a single wire, using any means of support which were convenient and cheap. As the business grew, however, the property owners objected to having wires attached to their houses and barns, and it became necessary to build pole lines in the streets. These telephone pole lines were, in every respect, the same as the pole lines which the telegraph companies had been building for some time, and they served the purpose in the cities, until the growth in subscribers was so great as to make it impossible to handle the circuits in that manner. The earth return for the single wire was also, about this time, superseded by another wire for the complete circuit, and the modern metallic circuit, consisting of two wires, came into the field. This still further taxed the carrying capacity of the pole lines and other methods of distribution had to be devised.

Aerial cable was then introduced and while it would now be considered impracticable to use a similar cable on account of the fact that its mechanical and electrical qualities were, to say the least, very poor, it, nevertheless, served its purpose and for a time the telephone companies thought that their problems were solved. However, the orders for new stations kept coming in, and, in a comparatively short time, the capacity of the pole lines for carrying aerial cables was over-reached and the public began to complain of the unsightly and dangerous condition which existed in the center of the cities.

Underground conduit was then installed. This furnished a concealed method of handling the circuits in the principal streets, and, in connection with aerial cables and open wire construction, is a satisfactory method of reaching the subscribers' premises.

This underground conduit is constructed for one primary purpose—to carry cables. In some sections a system of underground distribution, leading directly to the subscriber's basement, as an extension of the underground conduits, has been attempted, but this has been found to be impracticable on account of the great expense necessary to install a system of this kind, and also to the fact that it is not flexible and will not take care of more than a small number of subscribers, for, as the subscribers have increased, the distribution ducts, as they are called, have become congested and the maintenance and depreciation accounts are so large as to make it inadvisable to continue a system of that kind, except in the cases of large office buildings where a lateral pipe can be run directly into the basement and the cable itself terminated at that point.

When a subway system is constructed it is evident that a considerable investment must be made to take care of future growth and it becomes the duty of the telephone engineer to decide just how large that conduit shall be. It is also a self-evident fact that a two-duct run, while costing slightly more per trench foot, is much cheaper per duct foot than a one-duct run, and that to enlarge a subway system which has once been laid is a very expensive piece of work. On the other hand, on account of the first cost and annual charges, it is, of course, improper to put down large conduit runs where they will not be necessary, and, as the number of ducts is directly proportional to the number of circuits they are to contain ultimately, and the number of circuits is, in turn, proportional to the number of subscribers which is to be located in the section which the conduit system is intended to serve, it is necessary to make an exhaustive study of that particular section for the purpose of determining as accurately as possible the number of ultimate subscribers, for long experience, together with theoretical figures, shows that it is economical to place conduits large enough, in all new runs, to handle the ultimate number of subscribers.

The subject of this paper is the telephone engineering necessary for the proper telephone development of a city. Under this heading you will realize that there are many factors which must be considered. It must cover the division of the city into the most economical number of central office districts, the determination of the best routes for the subway system and the number of ducts in each subway route that should be provided for carrying the underground cables, not only for serving the subscribers in each district, but, also, for connecting the districts together. The routes for these underground conduits at the ultimate may be assumed to be the best routes for aerial construction before it becomes necessary to build the ultimate underground plant. Therefore, such a development study practically consists of plans of the outside plant complete.

Development plans are based on assumed conditions at a date of, usually, twenty years later than the date of making the study and, also, on the assumption that, at that time, the number of telephone subscribers will equal about 15 per cent. of the population, where the city under consideration is of normal character. It, therefore, first becomes necessary to estimate as closely as possible what the population will be in twenty years, and a thorough knowledge of the city, its past history, rate of increase in population, together with any other facts which can be obtained from the city engineers or others who are interested, is absolutely necessary.

When the ultimate population is decided upon, it is a simple matter of calculation to decide what the ultimate number of subscribers will be, and it has been decided that the ratio of lines to subscribers may ordinarily be assumed to be about 70 per cent.

It next becomes necessary to estimate the probable ultimate ratio between business and residence stations, this ratio being, of course, dependent upon the character of the district which is under consideration. In a city of the character of New Haven, this ratio would be assumed to be about 60 per cent. of residence stations.

The next step in the development plans is the conduit study. The general principle involved in making this study is, that of cables is increased on a particular run. That is, one duct must be provided where the ultimate number of working pairs in the cable is estimated to be 100 or less, five ducts where this ultimate is about 1,000 pair, ten ducts where it is about 2,600 pair, etc. The total number of ducts necessary to serve the local subscribers on each run can, therefore, be placed definitely upon the map. It is customary to arrange for an additional duct on each run for the use of the city where they desire it, and still further, one or more ducts are also added on those runs which will ultimately carry toll lines to the neighboring cities.

Assuming that the ultimate conduit layout is completed, it is now necessary to decide just how much of this ultimate shall be built at once, for it is obviously unnecessary to install more than a very small proportion of the whole at the start. This is dependent upon the present number of subscribers, the possibility of using municipal lines and various other conditions of similar nature. Whenever a conduit is built, however, it is based upon the number of ducts which are shown on the ultimate sketch, and in many cases several ducts are put down where one would serve the purpose for some time.

[illegible] the size [illegible] the conduit [illegible] is determined and the [illegible] depended upon the [illegible] the same manner, that is, [illegible] should be put down [illegible] The depreciation and [illegible] are comparatively [illegible] in large cables is very [illegible] in small cables [illegible] wise to install [illegible] the estimated [illegible] several years and the [illegible] passing away. This [illegible] a matter of [illegible] method [illegible] the subscribers increase [illegible] present.

[illegible] reaching subscribers [illegible] some cases the [illegible] has been used as referred to in the first part of this article. This, in the case of large office buildings, and in the thickly-settled part of business districts, is probably the best method of accomplishing what is desired. To be entirely satisfactory, however, it is necessary to run the underground cable directly to the basement and from that point to distribute with service wires to the different instruments located in the building. A similar scheme of ending the underground cable in a manhole and from the manhole distributing to the basements of the near-by stations by means of service wires, through lateral pipes, has been found impracticable on account of various difficulties which have been encountered. All conduit runs are more or less exposed to various gases, dampness, etc., and no covering for the service cable has been found, except lead, which will withstand their action. Various forms of service wire have been designed and probably the best form consists of two rubber insulated conductors enclosed in a lead tube, this tube in turn being covered with a special cotton braid. The object of the cotton braid is to increase the tensile strength of the service cable, for with underground distribution it is often necessary to pull service cables 200 to 300 feet, and, under these conditions, the lead covering will not stand the strain unless it is reinforced. This makes quite a bulky service cable and where several of them have to be pulled into the same duct, there is a vast amount of friction between adjacent service cables. This, together with the fact that the service cables are bound to twist up more or less, when additional cables are pulled in, shortly leads to congestion in the duct, and in case of trouble it is absolutely impossible to replace a defective service cable without opening the street. The method, therefore, of serving the residential districts, which is becoming very generally adopted, is to run an underground cable through a lateral pipe, from the manhole to a pole located on the dividing rear line between the property owners, and from that point to construct a pole line parallel to the street along the rear property line. An aerial cable is run on this pole line, if the number of circuits warrant it, and aerial service wires are run from this cable directly to the rear of the subscribers' residence. A plan of this kind avoids pole lines in the street, which are objected to, in many cases, on account of their appearance, and also avoids the necessity of trimming the trees to [illegible] the [illegible] It is therefore the most [illegible] for serving that [illegible] [illegible] [illegible] streets, and these pole lines should be [illegible]

[illegible] the size of the outside plant has been [illegible] the location of the central office determined [illegible] becomes the size of the telephone equipment [illegible] kind and size of building to be constructed [illegible] size of switchboards which shall be installed [illegible] Here again the question of the ultimate number of subscribers [illegible] account of the number of subscribers [illegible]

[illegible]

Having obtained all of this data, a building is designed which, so far as it is possible, meets the needs of each department, and these plans finally go to the building contractor.

The switchboard specifications are next made up. The plans for the frame-work of the board are designed, as far as possible, to handle the ultimate number of lines which it is estimated will be installed during the life of the board. As much of the ultimate board is then called for in the specifications as will be necessary to handle the subscribers for about three years, the board to be extended from time to time after that, as occasion demands.

In the case of common battery offices, each call from a subscriber uses a definite amount of current from the storage batteries, for calling and talking to the operator, talking to the subscriber called for and signalling to the operator to disconnect after the conversation is finished. The size of the storage batteries and necessary charging dynamos are, therefore, dependent upon the number of calls or traffic which the office is to handle, and are calculated from the traffic data.

In this paper I have attempted to show that telephone engineering has ceased to be a matter of conjecture, and that a properly designed telephone exchange requires a vast amount of strictly engineering work before anything is accomplished. The haphazard, happy-go-lucky method of a few years ago has become as much a matter of history as the estimate of 5,000 ultimate telephones for the State of Connecticut.

DESCRIPTION OF THE NEW PLANT OF THE HARTFORD ELECTRIC LIGHT COMPANY AT DUTCH POINT, HARTFORD, CONNECTICUT.

By George B. Francis and Henry R. Kent.

LOCATION.

The electric lighting plant to be described is located on a small strip of land at the intersection of the Connecticut River and a tributary stream—known as Little or Park River—called Dutch Point.

It is of interest to note that probably the first engineering structure, if not the first building structure in the State of Connecticut, was erected on this site.

Site of Fort Good Hope.

As early as 1633 the Governor of New Amsterdam sent a troop of Dutch up the Connecticut River, who purchased certain lands from the Indians and established on this site a Dutch post, called Fort Good Hope.

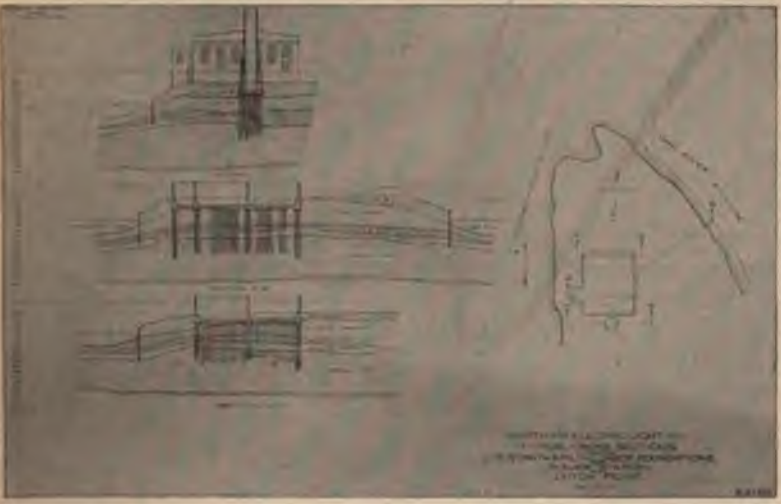
The same year Englishmen from Plymouth Colony settled at Windsor, a few miles further up the river.

About twenty years later, during a war between England and Holland, this fort was taken possession of by one John Underhill, captain of Rhode Island troops, who, a short time after, sold it to two different parties, giving a deed to each.

It was not our duty, fortunately, to trace the confusion of title resulting from such transactions, and probably the title of the Hartford Electric Light Company to this area has been well established in spite of this fact.

BORINGS.

The first proceedings toward determining the character of the foundation for the plant consisted of making sixteen borings, at a cost of about $300, to ascertain what lay beneath the surface and how far it might be to a firm strata.



TYPICAL CROSS SECTIONS SHOWING STRATA, ETC.

These borings were made by driving a 2-inch pipe at different points on the site to be excavated, and, at varying depths, extracting the contents by washing, or by taking out cores, which were preserved in small bottles. The average depth of these borings was about 80 feet.

An analysis of this data showed generally well-defined strata as follows: (a) about 5 feet of filled material; (b) 15 feet of a fine alluvial deposit; (c) 10 feet of black peat and wood, apparently a combination of decayed leaves, brush, drift wood and other vegetable matter, which had been left there by the river at some period long ago; (d) 5 feet (more or less in different borings) of fairly clear sand and gravel; (e) about 40 feet of a pasty brown clay; (f) hard pan; the total depth to hard pan averaging about 75 feet.

TEST PITS.

Two experiments were made to ascertain the supporting value of this material. Test pits were dug through the filling and into the fine alluvial deposit, which had the appearance of good moist loam of a uniform color and was found to weigh 59 pounds per cubic foot. Probably, as a matter of fact, this material in its natural position weighed a trifle more than water.

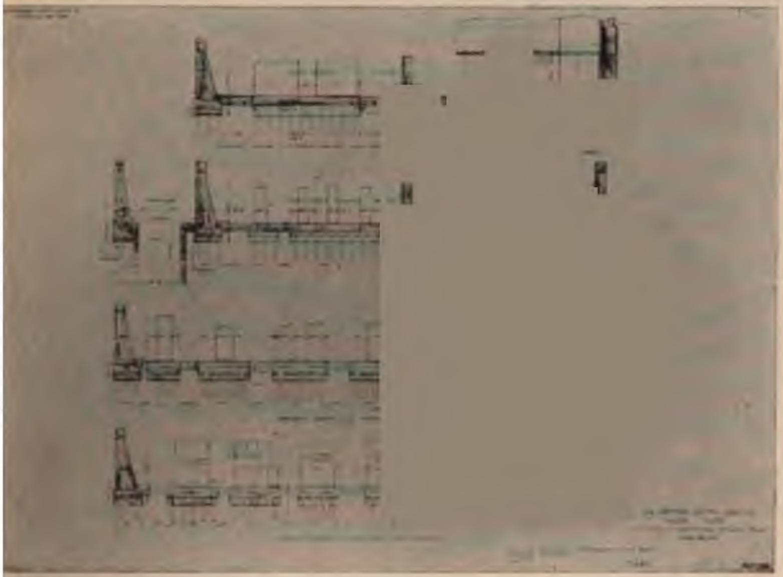
SITE OF PLANT, SEPT. 25.

Test loads were applied to this alluvial deposit in the following manner.

A timber base 3 feet square was built in the bottom of the test pits in the form of a plunger, of some vertical depth. Upon top of this base was constructed a timber box capable of holding a considerable load.

At the end of an hour, after a load of one ton per square foot had been applied, the plunger settled into the alluvial deposit ⅝ inch. At the end of eighteen hours the same load caused a total settlement of ¾ inch.

Under two tons per square foot the total settlement after one hour was 3 inches; and after eighteen hours, total settlement was 4 inches.



SECTIONS OF FOUNDATIONS SHOWING PILES.

Under three tons per square foot the total settlement after one hour was 4¼ inches; and after twenty-one hours, total settlement was 4½ inches.

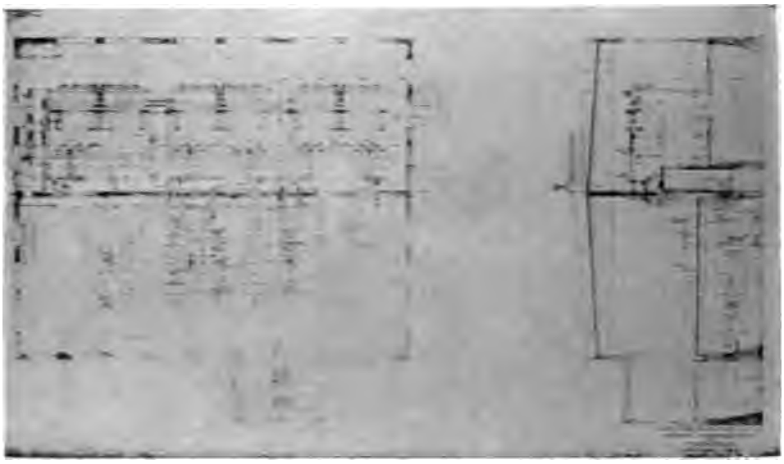
A second test load in another part of the foundation was as follows:

Under one ton per square foot the settlement after one hour was ⅝ inches. Under same load after eighteen hours the total settlement was a little more than ¾ inch.

Under two tons per square foot after one hour the total settlement was practically 2½ inches; under same load after fifteen hours the total settlement was about 2¾ inches.

The results thus obtained were very unsatisfactory, and showed that no assurance could be had that the building would not settle, or that settlement would be uniform.

The presence of the ten feet of wood and peat underlying the alluvial deposit strata, which in all probability would be compressible under loads, was another disquieting factor.

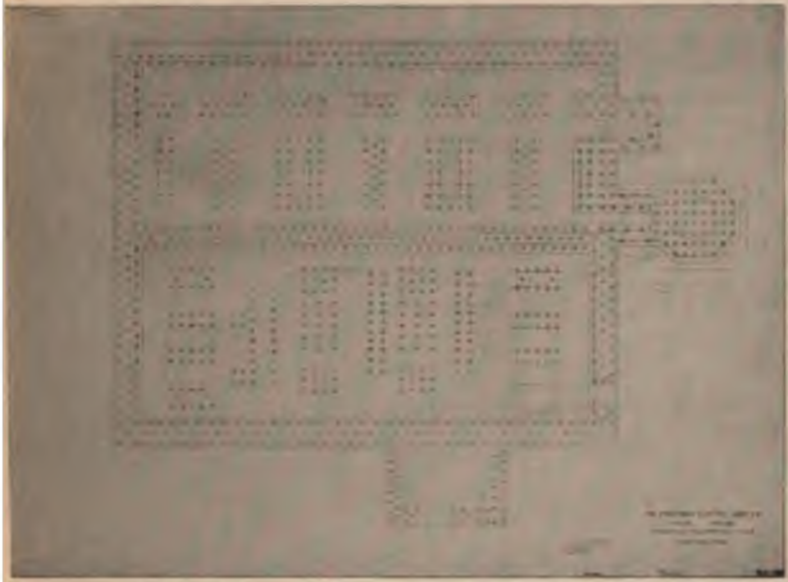


GENERAL ARRANGEMENT OF POWER HOUSE.

It was quite essential that electric current should be generated at this plant at the earliest possible date, and to economize time it was desirable to start the foundations (a large concrete base) on this alluvial deposit, without piles, could we determine that this was a safe procedure.

Pending final conclusion of the treatment of the foundation problem, excavation was started and the pit dug out to a general depth of ten feet. It was while this portion of the work was progressing that we obtained additional information regarding the alluvial deposit, which after careful consideration influenced us in the determination reached.

It was observed that the sides of the pit excavated stood up vertical for the ten feet in depth, although the material was so saturated with water that it was with difficulty the horses and carts were kept from being entirely engulfed. The site was close to and nearly surrounded by water and from 15 to 20 feet above it. We were puzzled at the presence of so much ground-water, which under usual conditions should naturally drain off, and an examination was made to see if this condition was not due to a leaky water main, but a careful search failed to locate any such leak.

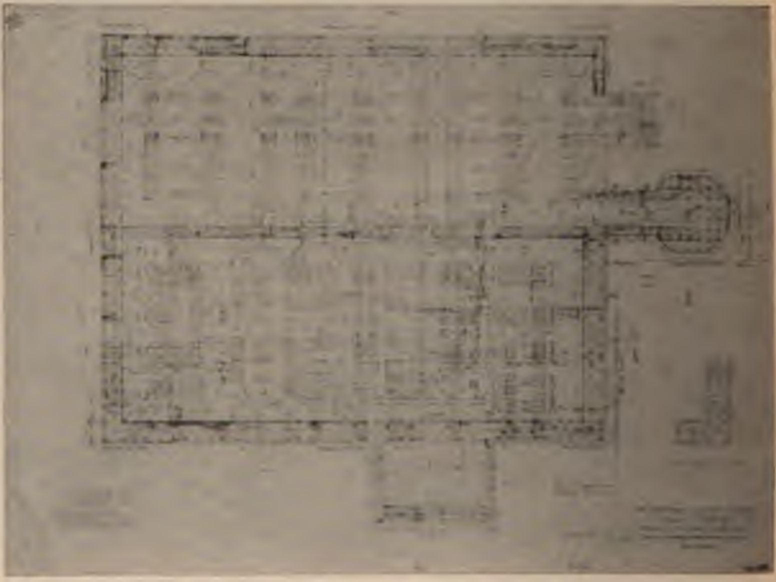


POWER HOUSE—DIAGRAM SHOWING NUMBER OF PILES.

The only reasonable solution was that this alluvial deposit possessed a capillary attraction which enabled it to hold water like a sponge; that frequent rains continued to saturate it, and that only a few feet of the top lost the water from evaporation. As this condition existed in a dry mid-summer, it was reasoned that perhaps we could safely drive piles and cut them off at a point about ten feet above low water level in the river, near by, and expect that they would remain saturated. This would save valuable time, a prime factor, and the large expenditure for excavation necessary to cut piles off below low water.

Our judgment was further confirmed by the condition of some logs that were found in this excavated material, which must have drifted there long before the country was settled, and which were in an excellent state of preservation.

It seemed reasonable to expect that the piles would last for a longer period than the power plant would be in service. A careful report of all the facts observed was made to the management of the Electric Light Company, and the pile foundation here shown was recommended and approved.



Plan of Piles and Footings.

Test piles were driven to determine a proper length and possible safe loading. The loads put upon the piles are in the neighborhood of ten tons each. They were ordered in lengths of 40-45 feet and driven to a depth sufficient to reach a fair distance into the brown clay.

About 1,120 piles have been driven under the structure. The average penetration due to the last blow was 4⅜ inches with a 2,300 pound hammer falling about 20 feet. The pile driving was started September 6, 1904, and was substantially completed October 29, 1904. No settlement has been observed in the completed structure.

In this connection the following quotation from a paper by Edwin Dwight Graves of Hartford, Conn., published by the Connecticut Society of Civil Engineers in 1904 is interesting:

> "Referring to the general subject of durability of timber in various conditions, the recent removal of the foundations of the piers of the old Hartford Toll Bridge furnishes interesting information."
>
> "This old bridge was built about 1818, and the piers and abutments were rough stone rubble masonry, apparently laid without much mortar except for pointing. The stonework rested on timber grillage bearing partly on timber cribs and filled with stone, and in some cases on piles very lightly driven in the sand and protected by riprap. In some cases these piles were cut off from 1 to 2 feet above ordinary low water and surmounted by a wooden grillage of hewn timber, on which the stone pier was built. These grillages, even above low water, stood safely for at least eighty years."

In this case, although the timber grillage had no protection like the contact of damp earth, when above low water, yet there is very good evidence of long life.

This finishes my remarks, and Mr. Kent will describe the plant.

The securing of this site for the new plant indicated a full appreciation of the requirements of a modern power house by the management of the Hartford Electric Light Company, as the location affords facilities for the unloading of water coal from the company's own dock, the delivery of rail coal from the company's own side track leading from the Valley Division of the New York, New Haven & Hartford Railroad, and an unlimited supply of water for condensing and other purposes from the Connecticut River.

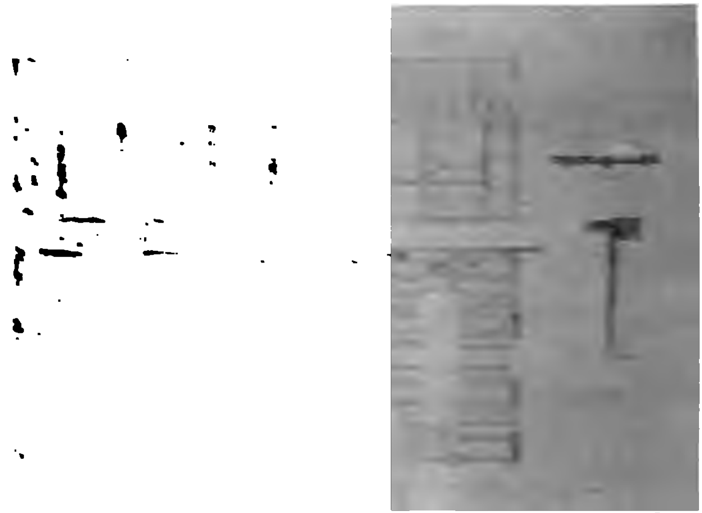
Notwithstanding these natural advantages there remained important problems for the engineers to solve.

The most serious consideration was that of providing the proper footings for the building and machinery foundations. "The oldest inhabitant" assured us that the bottom was perfectly solid, sand and gravel, and would hold anything we could put on it, and referred us to the buildings adjacent, which had been standing for many years. Our examination of the buildings showed cracks, and the borings confirmed our suspicions.

The method employed has already been explained.

The other difficulties could nearly all be attributed to the eccentricities of the Connecticut River.

The grade of the natural surface of the ground at the site averages approximately + 20, zero being extreme low water in the Connecticut River at the Hartford gauging station. Extreme high water mark is + 29.8, which occurred in 1854, and every year the river tries to approach this record. This [illegible] necessary to carefully consider the location



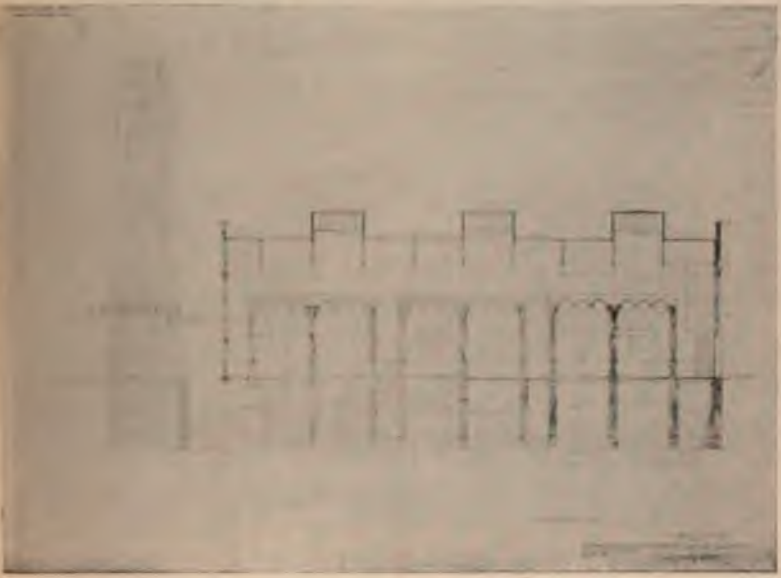
[illegible]

[illegible] basement walls [illegible] standing [illegible] thickness [illegible] distribute the [illegible] pressure.

as the top of the floor is at grade + 14.625. With the river at the maximum stage it would produce an upward theoretical pressure of about 1,200 pounds per square foot. The dead weight against this is 1,760 pounds per square foot.

The foundation or basement walls were made in the form of retaining walls, and are of concrete reinforced with steel rods. The company intends eventually to fill the land to grade + 30.5.

This construction allows of high basements under both turbine and boiler rooms, the former being established at grade + 34 to insure safety to the electrical machinery at times of high water, and the latter at grade + 31 to suit the established grade of the property.

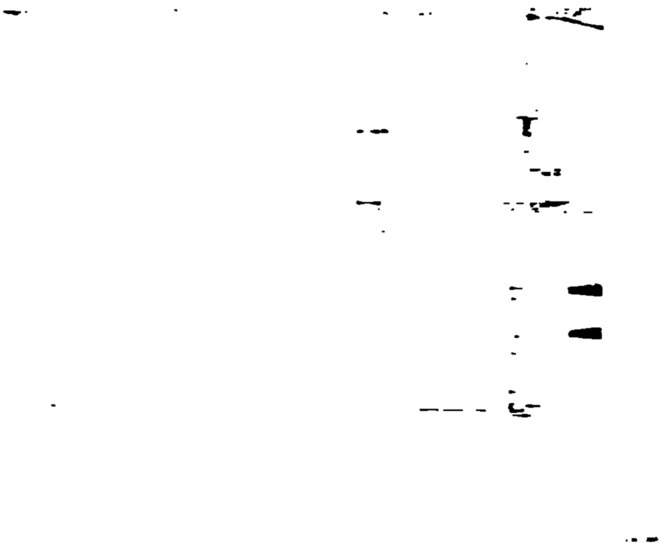


Power Station—Longitudinal Section through Boiler Room.

There has been no attempt made to waterproof the basement walls or floors, but simply to make them sufficient to withstand the hydrostatic strains due to high water. Such seepage as may occur will be removed by a special pump provided for that purpose.

The superstructure is of red brick relieved with sills, coping, and belt course of Longmeadow sandstone. The effect is that of a plain, substantial building made for a purpose.

The turbine and boiler room floors are of reinforced concrete carried on steel beams. The engine room floor is finished in white tile, and the sides of this room have a wainscot of the same material.



[illegible] Lines AA and BB.

[illegible] carried on steel trusses [illegible] windows to ensure ample [illegible] castings and for covering [illegible]

[illegible] lighting company has [illegible] than that which this city [illegible] current for lighting, [illegible] than any other city in [illegible] saving to her of the [illegible] maintain, the engineer [illegible] successfully the series alternating arc lights for street illumination, the first to use commercially the Nernst lamp, the first to see the possibility and to demonstrate commercially the economy of cooking and baking by means of electricity, and the first man in America to have the nerve to install a steam turbine and rely upon it as his principal source of power. There are many that follow but few who can lead.

Austin C. Dunham.

The 1500 K. W. turbine installed by the Hartford Electric Light Company some four years ago in the Pearl Street plant may be seen running to-day, and it was a natural sequence that the company should select this type of apparatus for the new plant.

The continued and growing demand has made it necessary to build this new plant to relay the several water power plants but this will not interfere with their operation, as they are driven by induction motors located in the pump room at grade + 34. The pumps and motors have vertical shafts and are direct-connected through a suitable thrust bearing. Each pump has an individual straight suction pipe ending in a strainer, but no foot valve at grade — 3, and a discharge pipe running to its own condenser. The pipes do not operate in parallel. The discharge from the condensers is carried separately from each in cast iron pipes, the outlets being sealed below extreme low water in the river.

In starting, the pumps are not primed in the usual way, but catch the water by aid of the air pumps, which exhaust the air from the injection line.

Considerable difficulty was experienced in building the intake flume to connect with the suction well, as it was necessary to cut through an old crib which was built when timber was plenty, and although probably one hundred years old, was in a fine state of preservation.

As the bottom of the flume was at grade — 4.5, it was necessary to coffer-dam the outer end in order to get in the trash rack guides and the concrete bottom. The sides are of sheet piling and the flume leads through a screen house to the suction well. The screens are in duplicate and are made up of hard wood frames filled with 2 [illegible] inch brass mesh of No. 10 Stubbs gauge wire.

The suction well is [illegible] feet inside diameter, and is carried down to grade — 4.5 and has brick walls and a reinforced concrete bottom. The brick was laid from the surface; the walls being started on a cast iron wedge-shaped ring, the earth being excavated from the inside, allowing the walls to settle as they were built, care being exercised to insure equal settlement throughout the circumference.

The condensers were built by the Alberger Condenser Company, and each contains [illegible] square feet of cooling surface, and in order to secure the desired high vacuum are equipped with [illegible] pumps. One of the condensers [illegible] units. The second will [illegible] unit.

[illegible] the engine room floor [illegible] inch diameter by 24-inch stroke, which drive direct-acting two-stage air cylinders, each 18-inch diameter by 24-inch stroke. These pumps remove from the steam space in the condensers the air and vapors, thus greatly relieving the condensation or wet vacuum pump, and allowing it to be designed to perform a single duty, that of removing the water of condensation from the steam space and delivering it to the hot well. These pumps are duplex, having cylinders 6 inches and 5¾ inches diameter by 6 inches stroke.

A peculiarity of the Westinghouse-Parsons turbine is that no oil is mingled with the steam that passes through it, and this point has been taken advantage of in the design to conserve the heat and pure water for boiler feed. With 28 inches vacuum the hot well temperature will be about 99° Fahrenheit. The hot well, in this case a sheet iron tank located under the boiler flue, delivers this water under a suction head to the feed pumps, which pass the feed through a heater having capacity to heat 135,000 pounds of water (50 per cent. more than the rated evaporating capacity of the boilers) from 100° to 148° Fahrenheit, when supplied with 7,000 pounds of steam per hour. At this rate the volocity in the heater coils will not exceed 250 feet per minute.

The exhaust for heating the feed water is supplied by the auxiliary apparatus.

The level of the water in the hot well is maintained by means of a float valve. This float valve operates an automatic valve in a pipe connection which forms a by-pass between the water space and the steam space in the condenser. When the water falls in the hot well the automatic valve opens and allows some of the injection water to enter the steam space whence it is pumped by the wet vacuum pumps to the hot well. In this way the centrifugal circulating pumps normally supply the make-up water for the boiler feed. This may also be supplied by the sump pump and from the city mains.

CRANES.

For handling the machinery in the engine room there is provided a 25-ton hand power traveling crane, equipped with two 12½-ton trolleys. This crane has a span of 46 feet 4 inches and a lift of 19 feet.

There is also a small crane located in the pump room for handling the circulating pump machinery. This is a 3-ton single girder hand power traveling crane with a span of 17 feet 4 inches and a lift of 14 feet.

PIPING.

The desire has been to design the various piping systems in this plant in such a way as to avoid complication and at the same time insure the greatest reliability and security.

The main system carries superheated steam from the boilers to the turbines. Each boiler branch is supplied with an automatic non-return valve and a stop valve. The function of the non-return valve is to prevent steam generated in the balance of the plant entering a boiler where the pressure may be down or where trouble may have occurred from the blowing out of a tube, or any other cause. This valve may also be used as a positive stop valve. Two valves are placed in the branch to insure protection to any repair gang that may find it necessary to enter a boiler when the balance of the plant is under pressure. As a further precaution there is an open drip provided in the boiler branch on the header side of the non-return valve to prevent accumulation of pressure should the stop valve leak.

The design allows the header to be kept relatively small (12 inches in diameter) as the boilers feed in and the turbines draw out in such a manner as to make this header practically an equalizing pipe.

Expansion is carefully taken care of by bends and by changing the plane of the pipes. The materials have been carefully selected for this work and are heavier than usually found in this class of construction.

The steam for the auxiliary apparatus is provided through a separate set of mains and is not superheated. There has, however, been provided a connection between the two systems for use in case of emergency. The exhaust lines from each turbine lead directly to the condensers, and each turbine is provided with an independent atmospheric exhaust, normally closed by means of an automatic relief valve.

In each turbine exhaust there is placed an hydraulically operated gate valve. The pressure to move the hydraulic piston is secured from the city water main normally, or from the boiler feed line should the city pressure fail. These valves were put in with the hydraulic mechanism for operating them on account of the time and energy required to close and open these valves, which for the 1,000 K. W. machines, are 28 inches in diameter. It requires about twenty minutes to open or close such a valve by hand.

The boiler feed piping consists of two headers carried over the boilers near their front end, made up of 6 inch pipe tapering to 4 inches on the end away from the pumps. Normally one header carries cold water and the other hot water, but they are so cross-connected at the inlet end that either line may be used for hot water, and so connected at each individual boiler connection that either hot or cold water may be fed as desired. The hot water piping is all brass, and the cold water piping is all extra heavy iron. The cold line is supplied with special connections for attaching hose for washing purposes.

The balance of the piping, comprising the circulating connections, the air and drip connections from the condensers, the air piping for cleaning purposes, the blow-off piping for the boilers; the piping for the circulating water in the oil coolers, and the oil piping, are such as are usual in stations of this kind.

STACK.

The products of combustion discharge into a flue located at the rear of the boilers. The top and bottom of the flue are formed of 2¼ x 2¼ inch Ts spaced 9 inch centers, carrying two stretcher courses of brick so laid as to break joints. One side of the flue is formed by the partition wall protected by an air space and lining of brick, and the other side is formed by the rear walls of the boilers and brick walls filling up the aisle spaces. Experience has shown that this form of construction makes a tight and lasting flue, but it is necessary to provide for expansion, and this is taken care of by means of a slip joint located just inside of the boiler room, the flue being carried into the brick and concrete base of the stack. The masonry base of the stack is carried up to grade + 48, and this is surmounted by a self-supporting steel stack 10 feet in diameter and 135 feet high, which gives an effective draft equivalent to 150 feet above the grates.

SUMP PUMPS.

The floor of the power house basement is arranged so as to drain into a sump to take care of seepage and wash water. and this sump is emptied by means of a low-service duplex Worthington pump having cylinders 12 and 14 inches in diameter by 10 inch stroke. This pump discharges through a 10 inch pipe leading outside of the power house to the river. The sump pump also has a branch suction leading to the suction well and a branch delivery to the hot well. so that in case of emergency this pump may be used to supply feed water for the boilers. as mentioned above. It is also used as an auxiliary pump in connection with the testing equipment.

AIR-COMPRESSING PLANT.

To supply the compressed air for cleaning the switchboards and generators, blowing boiler tubes, etc., there are in the engine room attached to the partition wall, two 11-inch Westinghouse Air Brake Company's direct-acting locomotive air-compressors equipped with automatic regulating valves which maintain the air in a storage tank located in the basement at 100 pounds pressure.

TESTING PLANT.

An interesting detail in the furnishing of this plant is a complete testing equipment for conveniently determining at any time, without interference with the operation of the plant, the steam efficiency of the apparatus. This consists of a system of scales and weighing tanks installed as a part of the permanent equipment of the plant. By means of a system of by-pass piping the wet vacuum pumps, which ordinarily deliver the condensation from the condensers to the hot well tank, can deliver this water to either of two weighing tanks carried on the scales. The flow to the weighing tanks is controlled by means of a three-way [illegible], which will deliver the water into either. These weighing tanks are equipped with quick opening gate valves connected to the bottom sheets, and both discharge into [illegible] the contents has been weighed. The [illegible] this water into the hot well tanks, [illegible] test the water is not wasted.

OIL COOLING.

In operating the turbines the oil for the main journals is kept constantly in circulation and at one point in the cycle it passes through a cooler, which is in the form of a small surface condenser. In this cooler the temperature of the oil is reduced by means of water which passes through the cooler and is supplied from a tank carried on the trusses of the boiler room roof. The water for this tank is supplied by a duplex pump located in the basement of the engine room, which takes its suction from

POWER HOUSE COMPLETED.

the intake well and is controlled by means of an automatic valve and pump governor, which maintains a constant quantity of water in the tank. Water from this tank is also used to seal the turbines against air leakage at the bearings. As a positive supply of water for these purposes is as necessary to the operation of the plant as the feed water for the boilers, there has been provided an auxiliary connection from the city mains, controlled by means of a separate float valve and float.

TOILET FACILITIES.

Separate toilet facilities have been provided in the station for the engine room and the boiler room operatives, and include shower baths and the usual conveniences.

The hearty coöperation of Mr. R. W. Rollins, General Manager, and Mr. E. F. Lawton, Superintendent, has made it possible for us to carry out the instructions which we received upon the placing of the contract, which were to rush the work with all possible despatch consistent with good construction, and the record is as follows:

The piling was started September [illegible], 1904, and was completed October [illegible], 1904, and there were [illegible] piles driven. The concrete work was started September 22, 1904, and was completed October [illegible], 1904, and the total amount of concrete put in was about 4,000 cubic yards.

The brickwork was started on October 8, and was completed December [illegible], 1904, and there were laid about 656,000 brick.

It is interesting to note that power from this plant was supplied for the commercial use of the Company seventy days from the laying of the first brick, or on December 18, and one hundred and thirty-six days from the starting of the work.

DEVELOPMENT OF SPECIAL TRACK WORK

ON STREET RAILWAYS AND ITS INFLUENCE ON TRACK WORK OF STEAM RAILROADS.

By Victor Angerer.

Street railways and street railway engineering have undergone a most marvelous development within the last twenty years. Before that time there really was no such person as a street railway engineer, and anyone who would have called himself a street railway engineer in those days would have been looked down upon by the engineering fraternity in general, somewhat as a sculptor would look upon a stone mason. Some civil engineers engaged in other lines once in a while might have laid out a curve for a street railway. Then there was the contractor, who laid down the roadbed in the city streets with flat rails rolled by a few rolling mills, and there was the manufacturer of switches, frogs and curves for street railways, such as were used in those days, and these were the engineers. The street railways themselves, which were practically all horse railways, had a road master or trackman, but they had no engineer.

This is all changed now, and the great electric railway systems of the country rival in importance the large steam railroads. Street railway engineering has come to be a profession, and the problems and difficulties which the engineer of way of an electric railway meets and has to overcome are at least equal to those of the engineer of way of the steam railroads.

I shall endeavor to show you some of these problems and how modern street railway methods have been developed in that particular small part of the permanent way known as "special track work," comprising curves, switches, frogs, etc., and how the engineer of way of a steam railroad is actually just commencing to profit by the demonstration of the success of these methods as employed by the street railway engineer of way and as developed by the manufacturer of such special track material.

It will be necessary for this purpose to give you, by means of some illustrations, a short history of the gradual development of special track work on street railways.

This development is marked by four distinct periods. In the days of the "corn-fed motor," prior to the year 1884, we have the "flat rail period." The track was laid with flat rails, spiked to a wooden stringer, which in turn was fastened to cross-ties, either directly by spikes, or by knees and spikes, the stringers being interposed between the rail and cross-tie, to give the necessary height for paving in city streets. For the curves a flat grooved rail, bent cold to the required curvature, was introduced in 18[illegible] by Mr. William Wharton, Jr. Prior to that the curves were made of iron castings in the shape of a grooved flat rail, but of course in short lengths, such as it was practicable to cast in the foundry. In some locations, particularly in New England, the grooved guard rail was only used on the inside of curves, while the outside rail was formed of a flat steel bar, on which the wheels traveled on their flanges, the guard of the inside rail guiding the car. The switches and frogs consisted of iron castings, sometimes chilled on the surface, with pockets on the ends to receive the adjoining rail. Under the light cars this kind of track gave quite good satisfaction and lasted for a long while. I have here a piece of curved rail of the flat rail type, which was in service in a quite important place in the city of New Orleans for [illegible] years.

Considerable ingenuity, however, had to be exercised even in those days to build some of the more intricate pieces of curve work, [illegible] had to be made in such a way [illegible] with the heavy traffic of the city streets, and special means had to be employed to take care of the small flanges of the wheels and the narrow treads on street railway cars, which as a matter of fact have not changed to the present day. [illegible] these narrow wheels and small flanges [illegible] subsequent revolution in the [illegible] track work, as I shall explain somewhat [illegible]

[illegible] mention that in those [illegible] mechanical means were [illegible] supplant the track work. [illegible] were frequently used, also transfer tables. I remember at the terminal of a line in Brooklyn a transfer table at the end of a double track. The track on which the cars arrived was on a somewhat higher level than the track on which they departed, and the transfer table was on a slight incline, held by a wire rope and counterweight. The car was run onto the transfer table, adding weight to the table, which then descended by itself on the incline until it came opposite the other track, when the car was run off again, and the table, relieved of its load, returned of itself to the position to receive the next car. Even the cars themselves were sometimes constructed to be turned around on the dead end of a track by means contained within the cars themselves, as the curious pictures will show you.

LAYOUT OF THE FLAT RAIL PERIOD.

The drawback to the old flat rail system was particularly that the wooden stringers became rotten in time and the joints of the rails battered down into the stringer. The cars also became somewhat larger and heavier, and this led to the introduction of the girder rail on street railways, and we have the second period, i. e., the "Early Girder Rail Period," from about 1884 to 1891. While the first girder rail was laid in San Francisco in 1877, these rails did not become generally known until in the early 80's. The Johnson Steel Street Rail Company made a specialty of rolling them, closely followed by the North Branch Steel Company, controlled by William Wharton, Jr., & Co. The rails weighed from thirty-five to about sixty-five pounds per yard, were of a section both with and without a base; they were mounted on chairs of various descriptions, which in turn were spiked to wooden cross-ties, thus doing away with the wooden stringer. The special work consisted of curves bent from rolled rails corresponding in general form to the girder rails used in the straight track, but provided with a guard to guide the car wheels—in short, girder guard rails. The switches, frogs and crossings were of several distinctive kinds. First, built up of pieces of girder rail, planed and shaped to suit, and then riveted or bolted together, following out the idea of adapting to the street railway track the practice of steam railroads in the construction of frogs; but it soon became apparent that they were not well adapted to street railway track, in that the bolts and the rivets, becoming loose, and not being accessible, as in steam railroad track, to receive the constant attention and tightening up that steam railroads give to their frogs and crossings, but being buried in the pavement of the city street, could not get the proverbial "stitch in time" and the work, under the action of both the team and car traffic,

Layout of the Early Girder Rail Frogs.

shook apart before being worn out. Then, we have switches and frogs of chilled cast iron, similar to those of the old flat rail period, but also mounted on chairs, instead of the wooden stringer. These gave good satisfaction, except the joints, which were not in keeping with the rest. We further have work similar in construction, but lighter and made of cast steel or Mitis steel, but this in those days proved too soft or too porous to warrant the greater cost.

The cable railways and electric railways which then commenced to be established throughout the country soon demonstrated that neither of these constructions was adequate for the much heavier cars, and we come to the third period, or what I may call the Intermediate Girder Rail Period, from about 1891 to about 1895. The chairs under the rails are abandoned and the height of the girder rails is increased, up to nine inches, so that they could be spiked directly to the ties. For curves, guard rails of similar outline are used. The problem of the construction of switches, frogs and crossings was attacked in different ways by the various manufacturers, and we have again several distinct types, of which I will mention:

First, steel castings, somewhat improved in quality but still softer and more porous than the rolled rail.

Second, steel castings with pieces of the rolled rail electrically welded to the ends, to overcome the objectionable inaccurate fit of the joint plates on the ends of the first kind.

Third, chilled cast iron, with rolled rails cast into the ends, with the joints, therefore, as good as in the rest of the track, but while hard, still brittle, and therefore subject to spawling.

Fourth, rolled rails, planed and fitted similarly to the built-up work, but instead of being bolted or riveted together, they were united by moulten iron being run through and around the rails, eliminating the disadvantage of the bolted work, and at the same time giving the same metal, i. e. rolled steel rail, on all surfaces throughout the special track work.

Fifth, a combination of the cast iron and the rolled rails, somewhat similar to the fourth kind described, but with the cast iron in some parts exposed to the wear.

I will not go further into the relative merits or demerits of these various types, of which some are still used in places where the traffic is so light that it does not warrant putting down a more expensive style of work. They all have one common point of weakness—the parts which receive the greatest wear, where the same surface has to bear the traffic of more than one line, or where a narrower surface than the width of the wheel tread has to support the weight of the car, naturally wear down much faster than the rest of the work, and when the wear of these parts becomes objectionable, the entire piece has to be renewed. This weakness is inherent to all frogs, also steam railroad frogs, built up of ordinary rails, but is immensely accentuated on street railways by the narrower wheel treads which the street railways are compelled to use. The width of the wheel tread cannot be wider than the width of the head of the rails, without danger of striking projecting paving stones on the outside of the rails, and the width of the head of the rail is in many cities restricted by ordinance, mostly dating back to the old horse-car times. This width of tread is insufficient in many cases to span the groove of an intersecting track at the point of a frog or of the main track in branching off in the point of a mate. It therefore has always been considered advisable, in fact, almost necessary, in street railway work, to provide at intersecting grooves a riser, or flange bearing, i.e. the groove is filled up at its bottom, so that the flange of the wheel will bear on this filler and the wheel run on

LAYOUT OF INTERMEDIATE GIRDER RAIL PERIOD.

this flange where it theoretically loses its tread bearing. In castings, the metal of the casting itself is carried up; in built-up work separate pieces of metal are inserted, or the work constructed from specially rolled rails with shallow grooves. But the surface of the flange of a wheel presents a cutting edge rather than a bearing surface, and consequently these risers in work of the kind mentioned are soon cut down and then the wheels commence to pound and quickly destroy the parts where they have such an insufficient bearing, or where they have to jump across the space of the intersecting grooves.

To protect these parts was the simultaneous thought of several manufacturers. This led to what has been known for the past ten years as "hard centre work" and we have the fourth period, the Hard Centre Work Period. Two principal ideas were followed out in working up this problem. The one was to provide a separate comparatively small piece or plate, commonly termed the centre, at these points of greatest wear, which, when worn out, could easily be renewed without disturbing the rest of the work. Incidentally these centres were made of a somewhat harder metal than the surrounding parts. The illustration shows a frog, the body of which is made of cast steel, with a recess in the centre, into which is set a plate of Harveyized steel, with the grooves planed out before Harveyizing. The sides of the recess are undercut, and the sides of the plate beveled, or provided with projections, and zinc, or similar metal, is run into the space between the plates and the recess, forming a key to retain the plate in place. By chipping or melting out the zinc key, the plate could be removed. This zinc key, in practice, did not prove quite sufficient to hold the plate, and was subsequently supplemented by various other holding devices, such as wedges, bolts, etc. The body of these frogs is sometimes made of cast iron, instead of cast steel, with rails cast into the ends, in conformity with the method described in the earlier girder rail special work, without hard centres. The Harveyizing, of course, makes the surface of the centre harder than the surrounding parts. This hardness, on a sample which I have here, penetrates to a depth of somewhat less than one-eighth inch. Below that thin hard shell, the metal is quite soft, as can easily be ascertained by a drilling test. The next photograph illustrates a method in which the centre, made of tool steel, chrome steel, or some other harder steel than the surrounding parts, is simply bolted down, so that it can be renewed by unscrewing the bolts. The objections to the bolted-together work pointed out in the other periods apply to this. These are only some samples, as a great multitude of methods of fastening the centres into the pieces were designed and put into use, but I cannot begin to describe to you all these methods.

Of the metals mentioned, I have here samples of chrome steel in the natural casting, which appears rather soft and [illegible] porous. A forged piece of the same metal shows greater density, but is still not so very hard, and while it has considerable strength, is rather brittle. The regular [illegible]

[illegible]

Harveyizing locally of the surface of these parts in ordinary steel castings which constitute the pieces.

A method, in which incidentally there is a possibility of renewal of the centre, but which really belongs to the second category, consists of a centre of manganese steel, provided with lugs, which project through the main body, and by which the centre is securely anchored down by means of heavy keys or wedges driven through openings in the sides of the body. A bed of zinc is interposed between the centre and the main body, to insure a solid bearing throughout. The body of the pieces is made of cast iron or cast steel, with rails cast in the ends. The renewal of the plates necessitates the removal of a few paving blocks, to get at the openings in the sides to drive out the keys, after the bed of zinc is partly melted out, but as it is the intention that such renewal should only be necessary in case of accident to the centre or development of a hidden defect in same, this does not present any serious difficulty. In a recent modification of this type of work, large bolts and nuts are employed to hold the centre down, instead of lugs and keys. These bolts and nuts are entirely surrounded by zinc, which also forms the bed, in order to keep them from turning and rusting. The renewal of these centres, should it become necessary for any special cause, can be accomplished without the removal of any paving blocks, by melting or chipping out the zinc around the bolt heads and unscrewing them with a socket wrench.

Of all the various metals mentioned, I believe manganese steel, when properly treated, is to-day generally recognized as the best known metal for the purpose described, and by its use the idea of making parts of greatest wear last as long as the adjoining rails has been practically carried out.

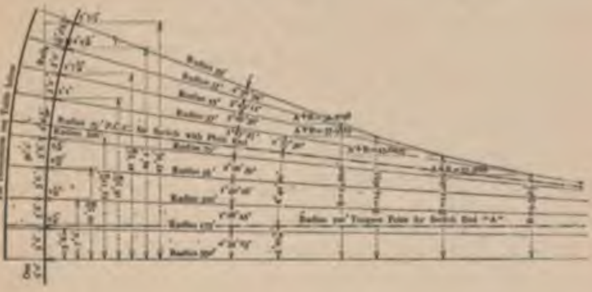
Manganese steel was invented or discovered by Mr. R. A. Hadfield, the great iron master of Sheffield, England. He confided his patent rights and processes for use in the United States to the Taylor Iron & Steel Company, of High Bridge, New Jersey. William Wharton, Jr., & Co., Inc., after experimenting largely with different metals, recognized the value of manganese steel for the purpose, and acquired the right for the use of the Hadfield manganese steel, made by the Taylor Iron & Steel Company, in track work. Mr. Hadfield discovered that an alloy of manganese and steel, containing over six per cent. and less than twenty per cent. of manganese, possessed the remarkable property that, while already very hard, when heated to a high temperature and suddenly cooled by plunging in water, it, in exact reverse to the action of the usual hard steels, became more ductile and tougher, without losing its inherent relative degree of hardness. This combination of hardness and toughness, produced by the treatment, when in proper relation, produces its great wearing qualities. This treatment of heating and plunging in water may sound very simple, but the proper and uniform development of the properties of manganese steel mentioned to produce the highest and best combination of hardness and toughness suitable to each purpose, forms the most important part of Mr. Hadfield's invention. Besides being covered by numerous patents, the proper treatment of manganese steel is in itself an art, which can only be learned by years of experience. The first patent of Mr. Hadfield, simply covering an alloy with the percentage of manganese stated, has run out, and therefore anybody can make the alloys, but if not properly treated it loses its value for the purposes mentioned. In the untreated state manganese steel castings, while already very hard, are brittle. When treated, as shown by some sample bars, it will bend and twist readily cold without fracture and at the same time will be so hard that a [illegible] make an impression on the metal. [illegible] while at the same time it will drill [illegible] ordinary Bessemer steel [illegible] difficult to handle in the foundry. [illegible] shrinkage is enormous compared with [illegible] making the production of intricate castings quite [illegible] ultimate strength is very great, and after [illegible] most remarkable elongation of specimens [illegible] its more general use for [illegible] machined, and all finishing [illegible] wheels. There are many [illegible] manganese steel is used with great success. [illegible] pins and plates, screens for [illegible] and doors for burglar- [illegible] some remarkable tests have been made [illegible] practically entirely [illegible]

Hard centre work in street railway special work to-day is practically the standard, and no street railway I believe would consider the use of anything else in important and complicated layouts. I show you here the same layout in manganese steel hard centre work that I have shown you before in the construction of the two previous periods. In connection with this, it might interest you to compare prices and length of wear of the constructions of the various periods. Work of what I call the second period, i. e. the early girder rail construction, was installed at this place in the summer of 1890. The material weighed 82,500 pounds and cost in round figures $3,100, or an average of 3¾ cents per pound. It was worn out and renewed with work of the third period in the spring of 1893, having lasted about two years and nine months. The material in this layout weighed about 100,000 pounds and cost a little less than $5,000, or 5 cents per pound. It lasted until the summer of 1897, a little over four years. It was replaced with manganese steel hard centre work, which has been in service ever since, with the exception of a few centres and about three or four pieces out of a total of seventy-six pieces, which were renewed within a year or so. This layout has, therefore, lasted so far nearly seven and a half years, a gain of nearly 100 per cent. in the service obtained. The material weighed 142,500 pounds and the cost in 1897 was about $5,700, or only 4 cents per pound, notwithstanding the expensive metal used in the centres. However, 1897 was a year of cheap material. Pig iron was then $11 to $11.50 per ton, T rails sold at $20 per ton at the mill, and girder rails at $24. To-day this layout would, on account of the use of a heavier rail and some strengthening of the pieces, weigh about 155,000 pounds and cost about $7,700, or a little less than 5 cents per pound, an increase of 25 per cent. over 1897, while in raw material, pig iron increased 50 per cent. to $16.50 or $17 per ton, and T and girder rails increased 40 per cent. to $28 and $34 per ton, respectively.

I am often asked how long such a piece of work should last. It is impossible to name a time. It depends on the amount of traffic, on the conditions of traffic, weight of cars and passengers, speed, weather conditions, tendency of the wheels to slide or turn at some points, and no uniform base can be established. I have tried by careful measurements of impressions taken of track in the street to average the wear of manganese steel centres per car, but had to give it up. The results I obtained varied from .0012 inch to .0020 inch of vertical wear per ten thousand cars. Mr. Hadfield, in making similar tests, observed a vertical wear of from .0008 inch to .0023 inch per ten thousand cars, at different points of one layout. Variations amounting to from 100 to 200 per cent. of course do not admit of any conclusion. A difference of opinion also naturally exists as to when a piece of special work should be called worn out. I show you a photograph of a centre which was taken out after 2,570,000 electric cars had passed over it, and it does not seem to be worn very much. On the other hand the extent to which rails are sometimes allowed to wear in street rail special work seems to me to be remarkable, as illustrated by the photograph.

When the electric street railways branched out into the country where they were not restricted by the regulations of a city [illegible] the use of T rails and the general [illegible] of steam railroads for special track work was [illegible] except that where team traffic on country highways was liable to encroach upon the track, tongue switches, similar to the construction used in city streets, but built up of [illegible] were used. The good results obtained by hard [illegible] work in city streets however soon called for an adaptation [illegible] special track work. Hard [illegible] rails forming the frogs or crossings [illegible] similar to the girder [illegible] made comparatively light [illegible] metal, such as manganese [illegible] the important [illegible] a harder metal [illegible]

[illegible] special track work requires [illegible] which to one who has [illegible] are uncommon. As [illegible] rails cannot be [illegible] sections and special pieces [illegible] large amount of turning [illegible] very piece of special [illegible] be shop complete [illegible] working man of such a layout involves intricate calculations and a careful consideration of all conditions. As it finally passes into the hands of the track layer, it must contain data for properly locating the work in the street, as well as for the fitting of the work in the shop. The lines of the curves, as will be seen by the reproduction of the working plan on the screen, in modern special work, are not any more plain circular curves, as they were in the "corn-fed motor" times, but easements or spirals are introduced at the ends of all curves, to insure the smooth running of the cars and obviate the shock that was experienced from cars entering short circular curves. These easements or spirals usually consist of a number of sections of circular curves, increasing in the radius towards the tangent point, in imitation of a parabola. This, however, has to a great extent been overdone. The illustration submitted shows a simple spiral with changes of curvature every 3 feet 6 inches, and intended to be used for curves of less than 62 feet 6 inches central radius. By simply dropping out the first few radii, a 100 foot radius switch can be introduced into this spiral without disturbing the alignment of the balance. Spirals for curves of larger radii are derived from this base spiral, by multiplying the base functions by 1½, 2



Inside Radius	Deflection Angles		Co-ordinates of Centers		Inside Arcs		Outside Arcs Gauge 4' 8½"		Outside Arcs Gauge 4' 10"		Outside Arcs Gauge 5' 0"		Outside Arcs Gauge 5' 2"		Outside Arcs Gauge 5' 2½"	
	Partial	Total	B	A+B	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total	Partial	Total
350'	0° 34' 23"	0° 34' 23"	0.0000'	350.0000'	3.5000'	3.5000'	3' 6⅛"	3' 6⅛"	3' 6⅞"	3' 6⅞"	3' 6⅜"	3' 6⅜"	3' 6⅜"	3' 6⅜"	3' 6⅜"	3' 6⅜"
175	1 08 41	1 43 04	1.7500	175.0088	3.5000	7.0000	3 7⅝	7 1¾	3 7⅛	7 1⅝	3 7⅛	7 1½	3 7⅜	7 1⅜	3 7⅜	7 1⅝
100	1 40 16	3 23 20	3.3990	100.0335	3.5000	10.5000	3 7¾	10 9½	3 7⅝	10 9½	3 7⅜	10 9⅝	3 7½	10 9½	3 7½	10 9½
95	2 06 43	5 30 03	4.8780	95.0772	3.5000	14.0000	3 8⅝	14 5⅞	3 8⅜	14 5⅞	3 8⅞	14 5⅜	3 8⅜	14 5⅝	3 8⅛	14 6
75	3 27 27	8 57 30	6.7034	75.1600	4.5258	18.5258	4 9¼	19 3⅛	4 9⅝	19 3⅜	4 9½	19 3¼	4 10⅛	19 4	4 10⅛	19 4⅛
57	3 00 36	11 58 06	9.5983	57.5888	3.0000	21.5258	3 3	22 6⅝	3 3⅞	22 6⅞	3 3⅝	22 6½	3 3⅜	22 7⅜	3 3⅜	22 7⅝
45	3 49 21	15 47 27	11.0875	43.6490	3.0000	24.5258	3 3⅜	25 9⅜	3 3⅜	25 10⅜	3 4	25 10½	3 4⅜	25 11⅜	3 4⅜	25 11½
37	4 38 44	20 26 11	14.2613	37.0519	3.0000	27.5258	3 4⅛	29 ⅞	3 4¼	29 3	3 4⅜	29 3½	3 5⅛	29 4⅞	3 5⅛	29 4⅜
33			15.6021	34.1038												

STANDARD TRANSITION, PLAIN END, NO. 1.

and 3, respectively, and these four spirals cover the entire field up to curves of 500 feet radius. There are, however, several systems of spirals in use, prescribing ten or more different spirals to cover this range. Each manufacturer and many of the large street railways have systems of their own, in regard to spirals, requiring different calculations for each one to apply them to special work layouts, while practically, when laid down alongside of each other, the lines of these different spirals for a given curve vary less than ¼ inch at any one point. Some uniform standard in street railway spirals is badly needed.

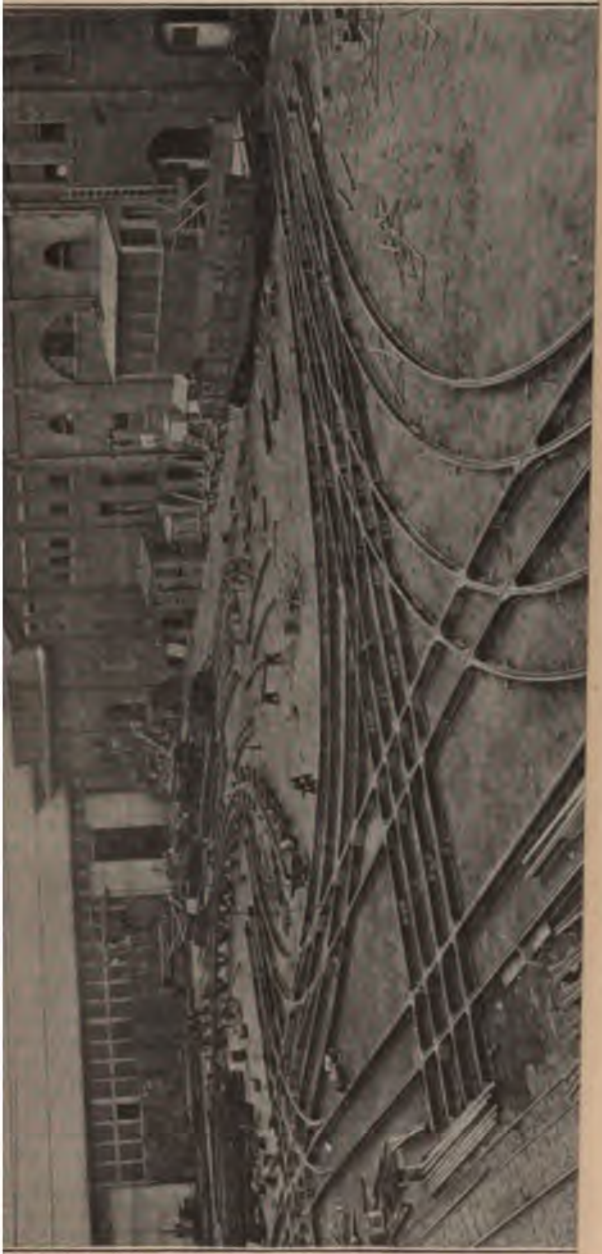
A look into the laying-out yard of a properly conducted special work factory would convince anyone of the great care that is taken in every detail and the rigorous inspection that the work has to pass before it is sent out, to uphold the reputation of the company.

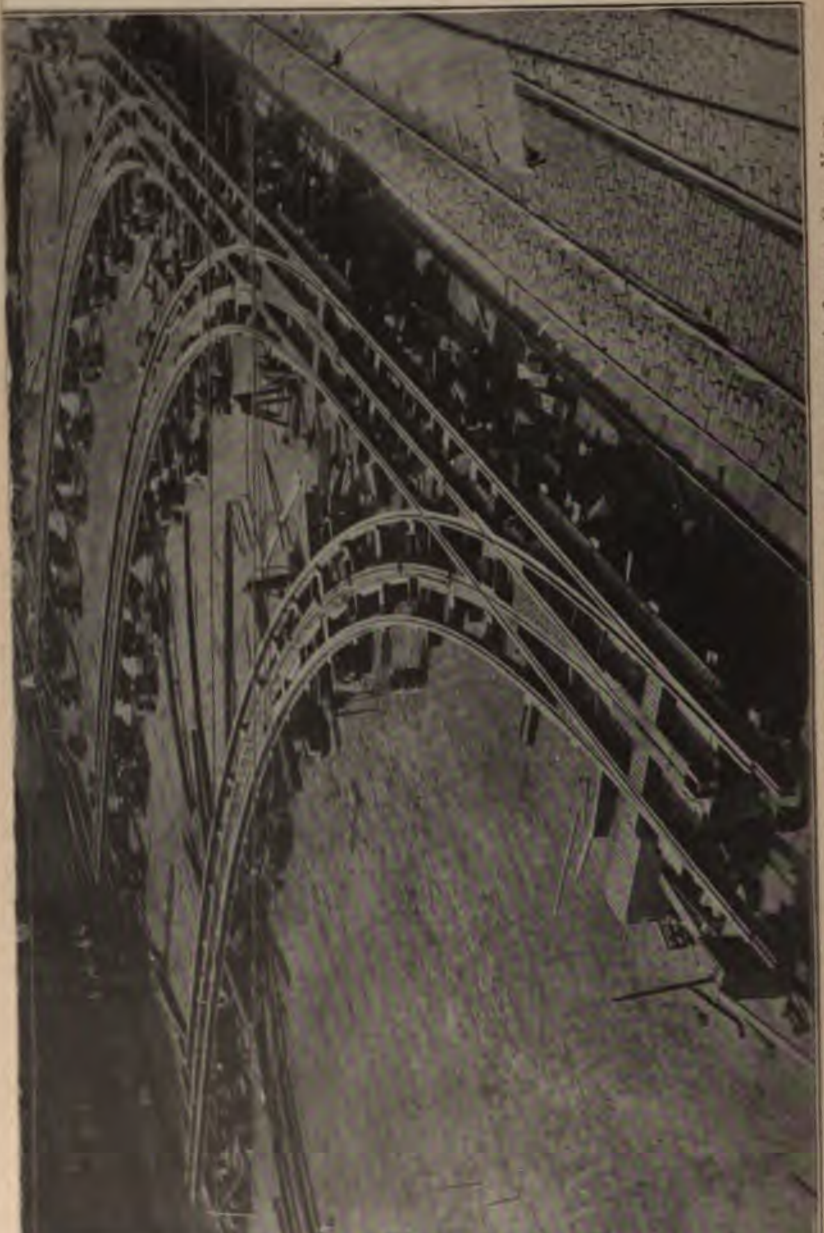
The following pictures will serve to illustrate some of the intricacies of ordinary girder rail special work layouts. To illustrate one of the detail difficulties, I show you a photograph of a plain curve, intended for a place where there is a marked change in the grade of the street, as set up in the laying-out yard. (See page 121.) The grade of the street must be reproduced, and the rails given an extra bend or twist, to suit this grade. Otherwise, a complaint that the rails are twisted is sure to come in. In other words, the parts must be twisted in the shop so as not to appear twisted in the street. (Page 123.)

Even in the loading and shipping of some of the bulky pieces forming part of a special work layout, there is some difficulty, and great care must be exercised, as illustrated by the picture of a carload of crossings. (Page 123.)

When the special track work of a street railway is further complicated by the introduction of a slot for the admission of a grip or electric plow, as for street railways with a cable or electric conduit, then its manufacture becomes intricate indeed. As cable railways were already introduced more than twenty years ago, the track part of conduit railway special work underwent the same stages as the work for the street railways without conduit. The photograph on the screen shows you a cable conduit railway layout of the first period, and you will note that the curves consist of flat rails, but instead of being spiked to wooden stringers, they are bolted to cast iron string

SPECIAL TRACK WORK.





Electric Conduit Railway Special Work as Fitted up in Manufacturer's Laying Out Yard.

pieces. Cable railways, however, are practically a thing of the past. They were given up probably because their operation sometimes became a "knotty" problem, as illustrated on the screen. They were soon followed in cities like New York and Washington, where overhead trolley wires were not allowed, by

SETTING UP A CURVE IN MANUFACTURER'S YARD TO FIT HEAVY GRADE IN STREET.

A CARLOAD OF CROSSINGS.

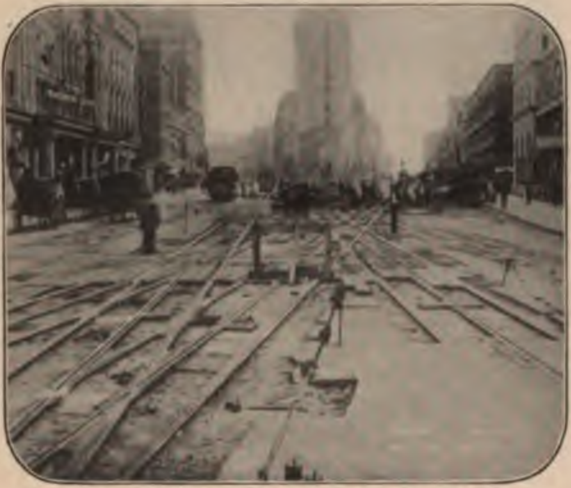
the conduit electric railways. It may interest you to see recorded in a photograph the not generally known fact that as far back as 1887 there was a conduit electric railway projected in the city of New York. It was to run on Fulton Street from the North to the East River, and the photograph shows a crossing over the horse-car line then on Broadway. This crossing was actually built, but was never used. The entire surface of this crossing was made of chilled cast iron. The difficulties and complications in conduit special work layouts will be appreciated by the photographs of such work, as set up in the factory before shipment. Various mechanisms are used for the slot switch, and means for throwing it simultaneously with the track switch. The hard centre principle has been extended to the points where the track crosses the slot; either by a hard metal plate fastened in the same way as described under hard centre work, or by solid manganese steel rails joined to the slot rails. (Page 122.)

INSTALLING OF LAYOUT AT BROADWAY AND WILLIAMSBURG BRIDGE PLAZA.

The installation of complicated special work layouts in the street presents many difficulties, particularly in busy cities. The street and car traffic must not be interefered with. The space of time between cars is usually so short that no attempt can be made to install a layout during the day. The following photographs illustrate some complicated layouts as they are being installed in the street. (Page 124.)

The handling of the very heavy and bulky pieces is sometimes very difficult by the limited means allowable on the street, and in view of the ever increasing weight of such pieces, the street railways have also come to the use of wrecking cranes.

With conduit special work, the difficulties of installation becomes still greater. As it takes of course longer to put it down, no chance can be taken of any delay, and very often it is considered advisable to again set up the entire layout on the street before putting it in place.



LARGE PIECE OF CONDUIT SPECIAL TRACK WORK.

Owing to the greater depth of the excavation for the conduit, many obstructions are met, such as rock and pipes in the streets. Sometimes, in cities like New York, a perfect network of the latter is encountered, especially at busy street intersections, where the most intricate special work is usually required. (Page 127).

The greatest difficulty in the proper designing of special work for street railways lies in the fact that there is no standard in the sizes of wheel treads, wheel flanges and wheel bases of cars in use, and yet each of these factors, combined with the radii of the curves, calls for a different width of groove, and the depth of the flange, for a different depth of the groove at the intersections. The diagram on the screen shows a few of the wheel flanges in use to-day on street railways, although it by no means covers the number of different shaped and different size flanges. The tendency of wheel makers has been to increase the thickness of the wheel flanges of a given depth, which has proven very troublesome in the making of special track work. The table underneath the diagram gives the width of grooves called for by the combination of the wheel flanges shown with the prevalent wheel bases, together with the radii of the curves. The diameter of wheels has been omitted, as a negligible factor.

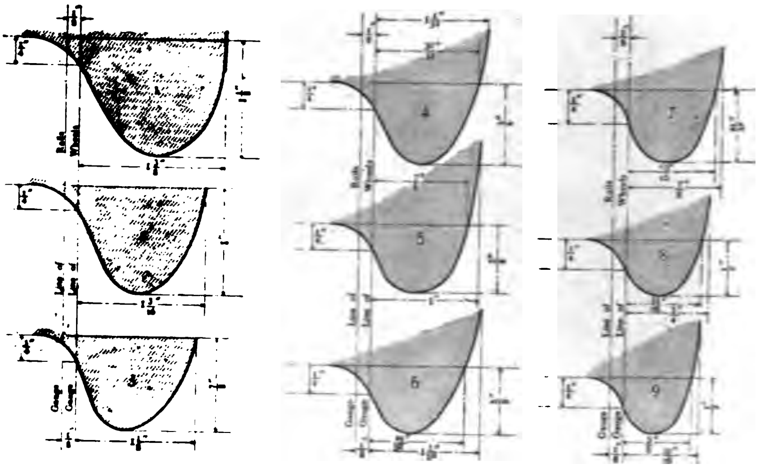
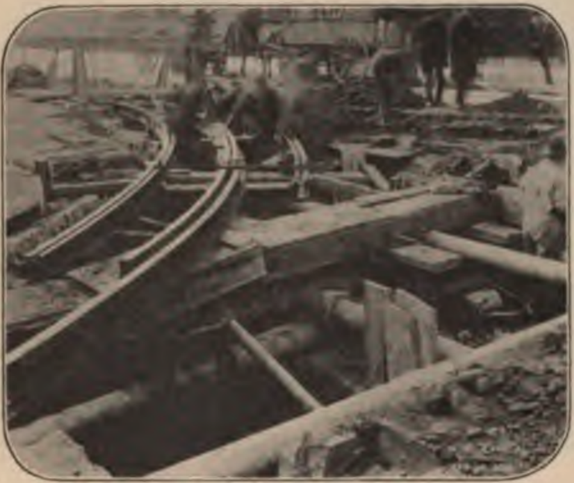


DIAGRAM OF WHEEL FLANGES.

Not only are different wheels used in different cities, but very often cars with widely different wheels are run over the same track. That it is impossible to make special track work to suit such conditions will be obvious. I am not now referring to the problem which has developed of late years of running suburban cars, which for their speed are equipped with larger flanged wheels, over the tracks in the hearts of cities, which are built to receive the smaller flanged wheels usually necessary to comply with city regulations. This is a problem for which the solution has not as yet been found. It may lay in wider wheel treads for both the city cars and the interurban cars, but for that the tracks throughout the city streets would have to be equipped with a rail that would admit of wider wheel treads. Some cities, like Philadelphia, have made a start in that direction. It may also involve deep but thin wheel flanges for both kinds of cars, with the wheels probably made of cast steel instead of cast iron. Another great difficulty lays in the lack of standards in the sections of girder rails used on street railways. The diagram on the screen speaks for itself. It shows the different girder rails now rolled. The number is nearly a hundred, and many obsolete sections which are not now rolled are in use in addition to these. One-quarter of the number of sections shown, I think, would cover all requirements, and satisfy all city regulations. The street railway engineers in that respect have not learned and profited from the steam railroad engineers, and have not as yet done for the street railways what the American Society of Civil Engineers has done for the steam railroads, in regard to establishing standards of rail sections.



OBSTRUCTIONS TO INSTALLING CONDUIT RAILWAY SPECIAL WORK.

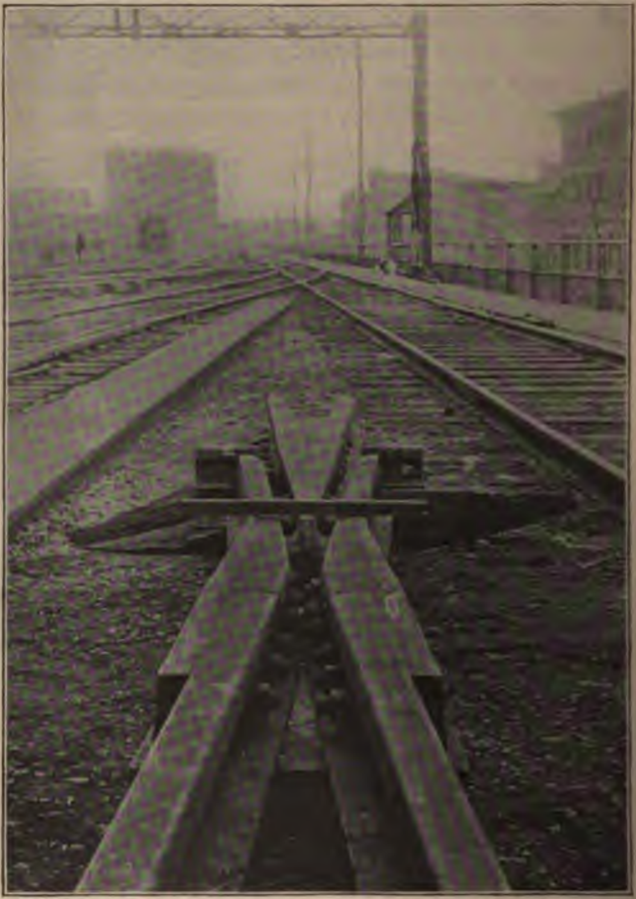
On the other hand, the steam railroads have profited by the experience of the street railways in regard to methods to increase the life of their special track work, i. e. their frogs and crossings, and will profit still more when the success of the application of these methods to steam railroad frogs, crossings, etc., becomes more widely known. I refer to the employment of a harder and more durable metal in the vulnerable parts, which in these frogs and crossings give out first. In steam railroad tracks, in city paved streets, they adopted the methods of the street railways outright, including girder rails, of a suitable heavy section, and special track work made exactly like that for the electric railways, only somewhat heavier. (Page 129.)

Modern Appliances for Handling Heavy Special Work Pieces.

The first step in that direction in regular high speed track was the introduction of what is known as "anvil face" frogs, in which pieces of a harder metal are set into the wing rails, which are usually cut out first by the action of the wheels. In the next stage, some steam railroads were directly induced by the street railways to try the use of a harder metal, like manganese steel, to a greater extent in crossings of electric railways over the steam roads. Such crossings are usually made by being built up of numerous rails, the steam railroad track consisting of the running rail, an auxiliary or easer rail on the outside of that, to prevent the blow of the overhanging wheel treads to the crossing rails, a guard rail and a filler between the guard and main rails. The engineers of the Philadelphia Street Railway system suggested that instead of these many parts, a single manganese steel casting, combining all these rails and fillers in one piece, should be used. The engineers of the two principal steam railroads entering Philadelphia were naturally and rightly cautious in adopting such a suggestion, but after witnessing a number of extremely severe tests of the metal, they felt safe in allowing its use under the heavy loads and high speeds of their trains. These crossings, proving eminently successful, finally led to the trial of manganese steel in regular steam railroad frogs. A test frog, cast solidly of manganese steel, was put into the tracks of the Pennsylvania railroad at Philadelphia on March 11th, 1900. It remained in service four years and forty-seven days, until April 27th, 1904, in a place in which the maximum life of an ordinary steel rail frog had been determined to be not more than three months. The frog was then worn down at the point about $^5/_{16}$ inches, but the rails on the end were worn considerably. (Page 130.) Allow me to tell you about a remarkable feat which was then accomplished with this frog. After being taken out it was sent back to the shop, new rails were fitted into the ends, the central part was then bent up to

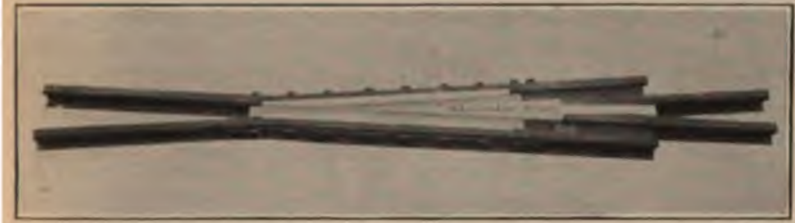
HARD CENTRE SPECIAL TRACK WORK FOR STEAM RAILROAD TRACK IN CITY PAVED STREETS.

the extent of the vertical wear, in a powerful hydraulic press, and the entire surface was ground level, at a comparatively small cost. The frog was then as good as new, and was put back into the track in the same place on June 30th, 1904, and is of course still in use. But long before these final results the merits and economy of the manganese steel frogs had been recognized, and they were adopted or put on trial in a somewhat modified construction by quite a number of the large railroads. You will



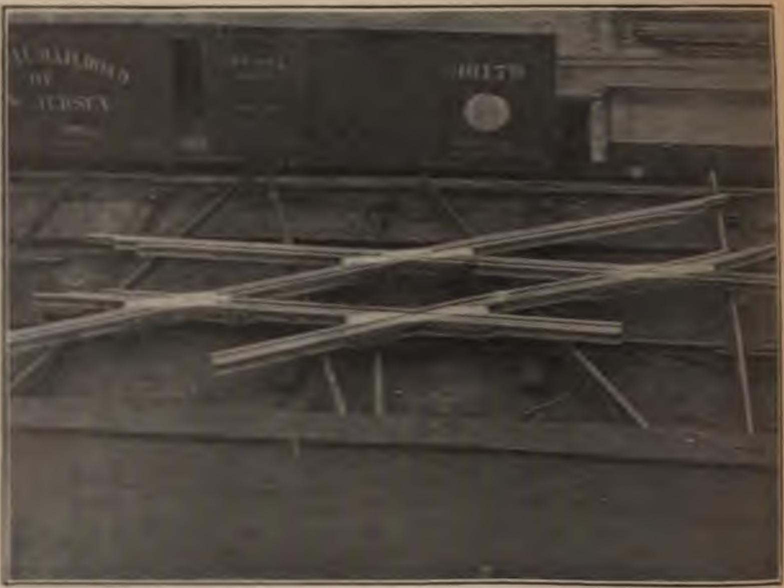
MANGANESE STEEL *STEAM* RAILROAD FROG IN TRACKS OF PENNSYLVANIA RAILROAD AT PHILADELPHIA.

see that the central part of this frog is a single manganese steel casting, forming really a frog in itself, bound in by rails, so as to give proper connections, and to make it possible to conform in total length with the standard of the various railroads, without the expense of carrying the manganese steel out to the full length. There are now over three thousand of these manganese steel frogs in use on the Pennsylvania Railroad and many other railroads of the country, besides many crossings, of which I exhibit a few samples in photographs.

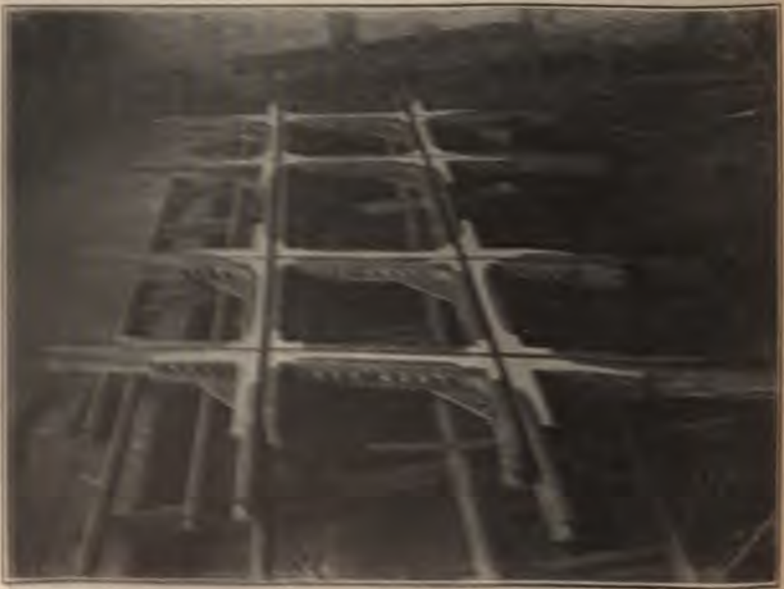


MANGANESE STEEL FROG.

BROAD STREET TERMINAL, PHILADELPHIA.



Manganese Steel Crossings.



Pennsylvania Railroad Crossing.

In the meantime the elevated railways, especially the Boston Elevated Railway Co., had taken up the use of manganese steel in some of its special track work. (Page 132.) The conditions of wear on the Boston Elevated Railway were most remarkable. Some curves made of 85-pound T rail wore out in forty days. The wear on frogs and crossings was equally severe, and, as can be imagined from the wear stated on the curves, was not confined to the points and wings of the frogs, but extended over the entire surface. Therefore it was not a question to make simply these points or portions of a frog of manganese steel, but the entire frog had to be made of that metal. Crossings had to be similarly constructed. Finally the Boston Elevated Railway approached William Wharton, Jr., & Co., Inc., in regard to the making of manganese steel rails for some of their curves. After some experiments, such rails were cast, not rolled, but cast in 20-foot lengths, somewhat heavier in the section than the ordinary rolled rails, so as to make the casting possible, and a curve was put in of this rail near the Park Street station, in the Boston Subway. (Page 134.) I take the liberty of quoting from a paper read by Mr. Steward, roadmaster of the elevated system of the Boston Elevated Railway, before the New England Street Railway Club, last October. He says:

> "On this curve, ordinary rail had been in the habit of wearing out in about forty-four days, measurements showing the wear of from .051 foot to .064 foot in that time. The manganese steel rail was put into the track in April, 1902, and is still in. It has been in place nearly one thousand days, and shows a top wear of only about .016 foot."

The price of this manganese steel rail was more than ten times that of ordinary curved rails, but in view of the above result no comment is necessary as to the question of economy. There are now about five hundred feet of manganese steel rail in use on the Boston Elevated Railway. Before putting this manganese steel rail into service, some of the rails were subjected to remarkable tests. A rail was curved cold to 20 feet radius. Half of this rail was then straightened out again, and curved the reverse way, again to a radius of 20 feet, and the other end was curved down to a radius of 10 feet, and there was not the least sign of fracture.

These remarkable results have induced the Pennsylvania Railroad to also experimentally try manganese steel rails, and an

MANGANESE STEEL CURVE, BOSTON SUBWAY.

interesting comparative test is about to be made by them, for which the rails have been delivered.

The principle of protecting the parts subjected to the greatest wear in track work by a hard metal is being applied to various portions of steam railroad special track work, made possible, of course, through the combination of hardness with toughness, as represented by manganese steel. A trial with split switches with manganese steel points is now going on, also manganese steel points for movable point crossings.

For some time guard rails opposite frogs have been provided with manganese steel facings; also some solid manganese steel guard rails have been put into use, and there are no doubt other numerous applications which will gradually develop.

In the general application and development of this principle, and in the testing out of the various metals for the purpose, the street railways were undoubtedly the pioneers, and I believe that I did not say too much by asserting that the steam railroad engineer of way has profited by—using the term in a double sense— the street railway engineers' "special work."

DISCUSSION.

MR. PERRY'S PAPER.

MR. A. B. HILL: Mr. Perry has given such a detailed description of the plant that I think there is very little more that can be said in the matter of the description and the construction. Possibly it might be a little interesting to call attention to some points in the preparation of the preliminary plans and the general design.

This plant is in some respects different from those that have been previously built. All the other sand filtration works, so far as I know, have been built with a groined arch roof, and the light is obtained by manholes in the crown of the arches. In this plant Mr. W. B. Fuller suggested three alternate plans for the roof. One was the usual form of elliptical groined arches with manholes at the crown of the arch for getting in the light, materials and so forth, the thickness at the crown of the arch to be six inches of concrete.

Another plan was the beam and slab construction, that is, large re-inforced concrete beams resting on columns, and on these beams re-inforced concrete joists and these joists supporting a slab four inches thick of re-inforced concrete.

Another plan was a roof of re-inforced concrete in a single span arch, that is, one span for each filter, one span covered the whole area of the filter. That gave splendid opportunities for light in the filters, and that was the plan that Mr. Fuller rather favored. But it was a very bold construction, and we had some fears about the effects of the expansion and contraction [illegible] of these large arches. The plan that was finally adopted after conference and consideration of all the different schemes was the one with a flat slab roof, and omitting the re-inforced concrete joists, that is, the roof consists of re-inforced concrete beams supporting the slab; the beams are on columns with about a 20 foot span, and a roof slab about 12 foot span.

One reason we omitted the concrete joists was the consideration in regard to light. The light in this plant, instead of being taken in overhead through manholes, comes in through windows on the end; and the omission of the re-enforced concrete joists would enable the light to be reflected up and down between the white smooth surface of the slab and the water, and give better results than if it had been broken up by the joists. And another reason was that the centers or forms would be much simpler in the construction adopted. The centers are very simple, and the work of construction is very simple. Perhaps it takes a little more concrete, but the preliminary estimates showed that of the three different plans suggested, there was very little material difference in the cost. Of course the details differed considerably, but the total result would be about the same.

Mr. Charles A. Ferry was the engineer in charge of the construction, with Mr. Ely M. T. Ryder as his principal assistant. Mr. Ferry is very much more familiar with the details of the plant than I am. If you have any questions about the detail, why Mr. Ferry can give you the information.

THE PRESIDENT: Gentlemen, are there any questions that any one would like to ask?

MR. KNIGHT: How much concrete did you get for a barrel of cement?

MR. FERRY: We used concrete in different proportions. I could not tell how that would figure out. We used four different mixtures of concrete in the works. Number 1 was composed of one part cement, and two and a half parts of screenings. For the roof we used 1:2:4; for the bottoms and columns 1:2½:4½, and for the walls, the same mixture, to which was added one part of tailings, this made about 1:2½:5¼.

MR. KNIGHT: You don't know how much concrete you secured from those different mixtures?

MR. FERRY: No.

MR. KNIGHT: The other question is one I don't know as I ought to ask, and that is, what the cost of finished work is per cubic yard of concrete.

MR. FERRY: That is a question I could not answer either, because the contract was let in a lump sum for the structure complete, and then so much a barrel for all the cement that was used in the work, so it would be almost impossible to determine.

There is one question I presume everybody who saw the plant last summer, and who will see it this afternoon, will want to ask, so I will ask it myself and then answer it. When you saw it last summer, the superstructure was a brick building. Now it appears to be a concrete building. I presume you will ask the reason why we changed. We did not change, we simply painted over the brick work. Our specifications called for brick work to be clean upon the completion of the work. That was a very easy clause to write but it was a very difficult thing to carry out, because in putting concrete on the roof we used very wet concrete, and the water from the concrete would run down in the joints between the moulds, and the brick work was streaked with the cement from top to bottom. We did not anticipate that we would have very much trouble in getting it off; but when we attempted to do so, we found that the brick had absorbed this fine thin grout. We tried different kinds of acids and wire brushes and scrubbing it with sand. The only result was we made it look a little worse. We thought we would have it all look alike, so we painted it all over with a thin coat of grout. We painted it over two or three coats so as to get a uniform color. The bricks show through, but at a distance it looks like a concrete wall.

MR. BURT. I would like to ask if Mr. Perry thinks that would increase the life of the brick at all? I notice in New Haven here in a number of their works, that they have washed the brick work, especially on the face of bulkheads, with a cement wash, and whether in his opinion, that increases the life of the brick work at all?

MR. PERRY. We used very hard brick for the brick work, and as far as I know, the brick would last forever. Whether putting cement on would make it last a little bit longer than forever I don't know.

We have had some very interesting frost work out there on the sides and ceiling. We expected to have heat in there early in the season, but we have been delayed. The water from the roof runs down into the [illegible]. The tile pipe which takes the water off is about three-quarters inches in thickness, so that we cannot drain it down within three-quarters inches of the bottom of the beds, consequently the bottom of the beds are covered to that depth. The water does not freeze, but of course it evaporates to a certain extent, and comes up into our operating gallery, and freezes. It is a little bit colder there than it is outdoors, and the moisture condenses on the walls and windows, and we have some striking work of the frost, fully half an inch thick sometimes. It is very beautiful to look at, but the effects of it are not so beautiful to contemplate.

A MEMBER: I would like to ask about the thickness of the three coats of concrete. My experience has been that the least thickness you can get on to brick, applied in the liquid form of cement, the better—the better it would adhere, and the longer it will stick to it. I found by putting a very thin coat of plaster, as thin as a mason could put on with a mason's trowel, much better than a coat put on three-sixteenths or even one-quarter of an inch thick. A one-quarter inch coat would come off in a very short time, especially if it was exposed to the weather, or where there is any water in back of it where it could freeze?

MR. FERRY: This makes a very thin scale. I should imagine it would be about one-fortieth of an inch thick. It is very thin. The grout is applied very thin so as to have it get into the pores of the brick and adhere.

MR. MCKENZIE: Just one question: what was the total cost of the works, and the total capacity in million gallons per day; that is, I want to get the cost of filtration per million gallons?

MR. FERRY: Well, that I don't know. We haven't had the figures to compare. Part of the work has been done by contract, and part of it paid by unit prices for the cement. The water company has done a great deal of work by day work, of which we have no account whatever. I presume likely the total cost of the plant will be something like $300,000. The maximum rate of filtration will probably be about 20 or 21 million gallons a day, but we do not anticipate filtering at that rate, but only at the rate of from five to ten million gallons a day. This plant is a sort of a balance wheel for the water company's water supply. They take all the water they can get from the gravity supplies and then the deficiency is made up from this supply. For the last month or two, they have been pumping from that source about 12 or 13 million gallons a day. But under ordinary conditions they won't run over 5 to 10. The average, take it through the year, will probably be about 8 million gallons a day.

MR. KELLOGG: Mr. President, I would like to ask one or two questions, and they are rather related. Is all of the water coming to the city from Lake Whitney to be filtered, and if not, in what way would they regulate the supply of filtered and unfiltered water? I supposed it would all come through the filter, and this water and the water coming from Saltonstall, and the other ponds would mingle with it. Now the paper very well states that these other sources are supposed to be in better condition than Lake Whitney, on account of the company being able to guard the banks better and the tributary streams. I remember, when the question of filtering the water of New Haven was first discussed, talking with Mr. Dillon, the Superintendent and asking him if he thought they would filter all the water that came into the city. He said he didn't know, but he thought it was rather an expensive thing to filter water to wash carriages with. I didn't know whether there was any separate plant to be installed for the purpose of issuing the two kinds of water or not.

MR. [illegible] the water that comes from that source of supply [illegible] when we get the filters in operation. [illegible] all arranged so that in [illegible] the water directly [illegible] be deprived of that [illegible]

[illegible] different classes of water [illegible]

[illegible] sources. All of our [illegible] the atmosphere of the [illegible] This supplies [illegible] the atmosphere, and [illegible] In all the [illegible] which [illegible] [illegible] here and the [illegible] supplies [illegible] was made as to what [illegible] the quality of water is different in the different supplies, so that by analysis of samples of water taken from different parts of the city, the general outline of the territory covered was pretty clearly defined. Of course it varies between night and day depending on the draught in different sections of the city, but in the central part of the city, everything east of College Street, and perhaps a little west of College Street, perhaps as far west as York Street, and as far east as Hamilton or Wallace Streets are probably supplied with Lake Whitney water. The western part of the city is supplied from Woodbridge, and Fair Haven, and the eastern part, as far as perhaps Hamilton or Wallace Streets, comes from Lake Saltonstall. At present we supply about 25 million gallons a day, and our population is about 125,000. Of course this large amount is due to cold weather. As soon as it becomes warm weather, along in April, the supply will probably drop down to perhaps 15 or 16 million gallons a day, as the consumption decreases about that time. In the summer season it will run up again. Along in July and August the consumption will increase. But in the spring months, when the people are not watering lawns, and when the weather is cold enough so that they do not have to let it run for grass and gardens, and warm enough so they do not let it run to keep from freezing, then we have our normal supply in the spring and fall.

MR. KNIGHT: What was the reason for laying the slab floor in two courses.

MR. FERRY: The floor is built in two separate layers. The first layer was four and three-quarters inches thick and was built in blocks. Most of them were about 12 feet by 20 feet 2 inches. Then the second course was thick enough to make it up to from 8 inches at the bottom to 18 inches at the top of the inverted arches.

MR. KNIGHT: What was the reason for doing it in two layers? Couldn't it have been done in one?

MR. FERRY: It might have been in one, but we didn't want the concrete joints to run straight down to the ground. The courses were laid so that blocks in the second course were diagonal with those in the first course. The point where the joints in the concrete cross comes in the center of the column which supports the roof, and that is covered at that point.

MR. EVERIT'S PAPER.

THE PRESIDENT: Gentlemen, you have listened to Mr. Everit's very interesting paper, and I think that that goes to show that each man in his own particular line of engineering often does not give credit to the other fellow for the difficulties he may reach in his own work. Personally my idea was that telephone engineering was about this way: the first step in the preliminary survey would be a canvasser, who would go out and see if he could get a customer. If he got a customer, then he would come back to the treasury department and would see whether the prospective customer was good for the bill. Then his next move would be to go to the construction department, and they would tell him to go out and tack his wire upon a building or telegraph pole and that was all. I hadn't any idea that they went into it with such detail as they do. Are there any questions any member would like to ask Mr. Everit?

MR. KELLY: Is there any care taken now in giving a grade to your conduits towards the manhole, or is there any trouble from water?

MR. EVERIT: So far as possible we carry to the street grade and drain the manholes. We leave no sags between manholes.

MR. KELLY: Is there any serious objection on account of electric current, to carrying electric wires, for instance, through conduits immediately adjacent to or in immediate connection with your telephone conduits?

MR. EVERIT: It depends on what the electric light voltage is. So far as possible we avoid having any electric wires in the underground system near or adjacent to our conduits. We have had trouble at several points where the underground service pipes of the electric light company crossed our conduits, and where the pipes themselves were practically in contact with our pipes. The electric light circuit became grounded in their pipes, and the current went to our pipes and cables, and not only burned out our cables, but also set fire to the terminal apparatus where they ended.

MR. KELLY: Did this trouble arise in the conduits or in the manholes?

MR. EVERIT: In the conduits.

MR. KELLY: In your opinion wouldn't it be feasible to so construct the conduits as to be entirely safe?

Mr. Everit: Well, the practical conditions are that we find that we have to control our own manholes as far as possible, and adjacent conduits usually mean common manholes. Our cables are no heavier or stronger than they have to be. While we can control our own men, we cannot control other company's men; letting anyone go into the manholes, at any time, is very apt to cause mechanical trouble to the cables, and we therefore avoid it as far as possible.

Mr. Burt: I would like to enquire, if it is a proper question, what the ordinary expense would be of putting the telephone service in conduits, say, 200 feet, the depth of the lot, from the street to the rear of the house?

Mr. Everit: You mean in connection with this back yard distribution?

Mr. Burt: Yes.

Mr. Everit: The question of expense is not a serious one at all, it is more a question of the right of way from the property owners. Each property owner has a nice garden in back of his house, and he seems to think that the ordinary lineman is going to spend his time running back and forth over the flower beds. The company would be very glad to get these back yard rights of way. The actual question of expense for installation of course varies on account of the length of the lateral pipe, the labor for excavating, and all that, but it is comparatively a very small item in the underground district.

Mr. Burt: It certainly would make a great difference in the appearance of the streets in the cities.

Mr. Everit: That is shown in many places, and probably the best sample of it is in Springfield, Massachusetts, where they have almost the entire residential part of the city covered in that way with practically no wires on the streets.

Mr. Kelly: It has been suggested that I push my question a little further on the subject of electric wires. It might not be impracticable to have separate manholes so that the conduits would be separated by a few inches. I would like to know whether that would obviate the trouble.

Mr. Everit: That has been done in a number of cases with very fair results, even one manhole with a dividing wall has been used. The only bad feature is the point where the pole laterals go out, or where the conduits branch out into the cross streets. It is all right on a straightaway run. To go into the cross streets one conduit has to cross the other conduit. On account of that we would probably have to throw a short dip in the conduit, and a dip in the conduit is bad.

Mr. Harte: I would like to ask whether you have any serious trouble from induction in underground work?

Mr. Everit: No, we have got rid of that entirely.

Mr. Harte: I noticed that you had the alternating light circuit with a comparatively high tension on the same poles and that doesn't affect you at all?

Mr. Everit: It affects us on the open wire work, but it does not affect us in the cable.

Mr. Hill: There is one point, about the trouble with high voltage, whether there is any very serious trouble with those high tension wires such as our friend Morton is letting down from the Housatonic river.

Mr. Everit: I think it has been generally decided that the best thing to do with those is to keep away from them. There has never been any method of construction devised that will absolutely protect the telephone circuit from 33,000 volts. Where we have to cross circuits of that kind, our crossings are especially designed for that purpose. The latest form where the telephone circuits have to cross under a very high potential circuit, is to put up a very heavy steel wire cable between the tops of the poles on each side of the crossing, the cable having more carrying capacity than the high tension wires. Each end of the cable is solidly grounded. Below the cable an insulated screen a trifle wider than the arms is put up: the scheme being that if the high tension wires break, they will strike the grounded cable and be burned off. The ends will then fall down on the insulated screen without touching the telephone wires.

Sec'y. Jackson: I would like to ask Mr. Everit: To what extent has the automatic exchange been installed throughout the country, and what has been the experience with it? It seems to me in many cases it would be a very good thing.

Mr. Everit: The automatic exchange is working, perhaps, more generally in the west than anywhere else. Grand Rapids, Mich., is perhaps the best example of it. There the people say it is all right, a splendid service and economical. A canvass of those people proves that the company is a coöperative affair, and about all of the subscribers are stockholders. I don't say that to give the idea that the automatic is not all right, but to show that it is hard to get an unbiased opinion of it. We do not think it has got to the practical point that it ought to be before it is put in general service. It is impossible to get any cost figures of the automatic people for maintenance; they have not got them, or if they have, will not give them out. The automatic people all say it is much cheaper to maintain than the manually operated system, but from what we can gather there does not seem to be much difference between them. We have now got one ourselves, that we are operating, in Westerly, R. I., and expect to have shortly some figures on it and know something about the cost. The service for local work is good, no question about it. It is claimed that it is quicker, and it is in some respects better than a manually operated system. On toll line service they are, however, putting in a manually operated board in connection with the automatic, so that the way it works, to-day, is the automatic for local work, and the manually operated board for toll line work.

MR. HILL: There is one matter in regard to the underground conduits. I think any one who has visited the underground conduits of Paris, the big storm water sewers, where the water mains and wires of all kinds are all in the same conduit, cannot help being impressed with the great advantages of that service. I don't know whether Mr. Everit has tried to see whether the different corporations could not come together and build one conduit suitable for all these different things. I don't know whether it would be practical; but if it could be done it would help very much in the matter of taking care of pavements, and save digging up the streets. In Paris all the work is done underground, and they have no occasion to dig up the streets, they have beautiful pavements and they are kept in good condition. Of course I can see that there would be very great difficulty on account of the installation that the present company has. Each company has their own installation, and it would be difficult to get them together and make the exchange into one big conduit. Of course there would have to be different conduits here, and I don't know whether Mr. Everit understands about that.

MR. EVERIT: That matter has not been taken up, so far as I know, excepting that in Chicago they have attempted to put in a system of that kind. There was a company that was chartered for that purpose. They never got very far along with it and the charter has now been sold to a company for a trolley subway. They, I understand, intend to lease rights for running pipes and cables. The Paris subway, of course, is the ideal way of handling the wires in many ways. They have had some very bad accidents in it, however, to the telephone cables, owing to explosions from leaks in the gas main. While I am not particularly well prepared to go into a discussion of the thing, I know that, from the telephone standpoint, they are not entirely satisfied with it. Gas, water, and public service corporations of that kind may be able to handle their pipes in that way from what they say, but with the telephone companies I know that it is quite questionable whether it is advisable or not, entirely on account of the danger of interruptions to the service.

MR. HILL: I think in some of the conduits there the gas is excluded, that is, put in a separate conduit under the sidewalk.

MR. GRAVES: Mr. President, I would like to ask one question, and it has reference to conduits in the same bunch, as you might say, or in the same trench, carrying different kinds of wires. In a case where there are no connections whatever, and the manholes are simply for the purpose of drawing cables through, would there be any serious objection to having the lighting cables, or the street railway cables, and telephone cables in separate conduits in the same trench.

MR. EVERIT: It is a question entirely of the distance between the conduits and the voltage of the electric light or power cables. The sheaths of the telephone cables are all grounded. Any possibility of an arc between the electric light and the telephone cables must be avoided, as of course, an arc would render the telephone cable useless, and probably absolutely ruin it. As I have said, we try to keep away. If that cannot be done, the complications have to be met and the conduit adapted to meet that particular case. The telephone companies would rather put in another conduit run and pay the additional expense of building it than to go into the same ditch with somebody else. I do not say we would not do it under special circumstances if necessary, but if it can be avoided, we prefer to do it.

Mr. Graves: Is not a concrete or a vitrified tile conduit between the electric and telephone cables quite as good an insulator as an earth bank between the two ditches?

Mr. Everit: Exactly. It is simply a question of how far apart the conduits are. We have had more or less trouble always where these conduits have been laid together, and, so far as possible, we have, therefore, kept away from the others. In all cases, if the question of an underground system in a city was coming up, we would be very glad to get together with the other companies and make plans for it, but if it is simply a question of putting in an underground conduit through a few streets, we find out where the other conduits are, and then we go as far away from them as possible.

A Member: Are you familiar with the results obtained by Mr. Dresser with concrete manholes as compared with brick manholes? In a new section of Springfield, he is using concrete manholes with very good success.

Mr. Everit: He is using them all over Massachusetts in the larger cities where he has underground work, and I understand they are satisfactory.

A Member: I wondered about the saving he seemed to gain by the use of concrete manholes.

Mr. Everit: They say, approximately, $20 on a manhole.

A Member: Is there any particular reason why that form of construction is not acceptable to the Southern New England Telephone Company?

Mr. Everit: No, there is not. In fact, we are considering it now.

A Member: There is another patent concrete manhole, made by a New York man, Mr. Hugh C. Baker. What is it?

Mr. Everit: That is much more expensive. It is made of concrete blocks.

A Member: What is the particular advantage gained by that particular form?

Mr. Everit: Simply the question of handling it in scattered districts. In places where we have only one or two manholes in small villages, where it is hard to get materials, the Baker manhole, I should say, could be used to advantage. The blocks can be made at some central point, where sand, cement, stone, labor, and so forth, are easily obtainable, and the moulded blocks can be shipped anywhere. It is a much more expensive manhole than Mr. Dresser's, because Mr. Dresser's method is to simply dig a hole in the ground, put a form in the center of it, and then shovel in the concrete around the outside of the form, letting the form stay there until the concrete hardens.

MR. GREGORY'S PAPER.

MR. MCKENZIE: May I ask Mr. Gregory one or two questions? Is there a sumpwell at the inlet end of the syphon?

MR. GREGORY: No, these pipes simply meet in the manholes.

MR. MCKENZIE: Were both of the 12-inch pipes at the same level?

MR. GREGORY: They were placed at the same level.

MR. MCKENZIE: Are both operated at the same time?

MR. GREGORY: They are both operated at the same time. If you want to use one of the 12-inch pipes, you shut one of the 12-inch gates.

MR. MCKENZIE: Those are operated by hand?

MR. GREGORY: They are operated by hand power.

MR. MCKENZIE: Is there a perpendicular drop at the end of the syphon, or is it sloped in each direction from the end?

MR. GREGORY: No, the drop is vertical. Then there is a well, a slight grade at the bottom of the syphon, about 1 in 200, the rest is vertical.

MR. KELLOGG: I would like to ask Mr. Gregory the size of the two pipes that enter this outfall?

MR. GREGORY: The two pipes are 15-inch pipes, and the pipe running to the channel was 12 inches.

SECRETARY JACKSON: Mr. President, I would like to ask Mr. Gregory, in regard to the work on pile and timber foundation, as to the progress of the work, how much was laid in a day and how many men were employed in a day?

MR. GREGORY: About that I could not say. That was tide work, and they worked four hours one day, and perhaps another day they would work eight or ten hours. Of course under a contract price, there is the pipe, concrete, brick and the piles and timber, and it would cost about $4.70 a lineal foot complete.

MR. FERRY: I would like to ask how long the syphons have been working and whether he has ever had occasion to flush them out?

Mr. Gregory: This sewer was built, and I think it was finished in June, 1903; since they commenced to use it they had occasion to flush it once; but outside of that, there has been no trouble at all. Part of the time we have been using one pipe, and part of the time we have used two. In the summer we use two because the draft on the sewer is a little more, many people having their summer homes in Greenwich. In the winter time we only use one pipe.

Mr. Ferry: Do you have any trouble in flushing it out?

Mr. Gregory: No, we have no trouble whatever. The trouble was from laterals being built, and there came a heavy storm and washed in quite a little dirt. This dirt reached and dropped into the first syphon. One pipe was set back for a little while. This was noticed, and as soon as the gate was shut and the water turned in, we had no further trouble.

Mr. Ferry: Just took the pressure of the water?

Mr. Gregory: Just took the pressure of the water, gave it full pressure.

Mr. Verrill: I would like to ask Mr. Gregory what the elevation of the outlet sewer is relative to high or low water?

Mr. Gregory: That is designed to be just low water, zero.

Mr. Verrill: What is the grade crossing the island?

Mr. Gregory: That is one foot in 600.

Mr. Verrill: Has there ever been any provision made for dredging at the outer end?

Mr. Gregory: No, there has not. They thought they would have to do something there, but nothing has come up as yet. They did talk one while of dredging from the outlet, dredging the channel out further into the harbor, but for the present it seems to be dropped. I think likely it will be taken up in the spring, although I am not sure.

Mr. McKenzie: May I inquire what distance out in the harbor, or what distance from the shore, is the outlet?

Mr. Gregory: The distance from the road out to the far point of the island is about 1500 feet in a direct line.

Mr. McKenzie: Is there any provision in the way of storage chambers, or letting it out on ebb tide, or does it run continuously?

Mr. Gregory: Not at present, no.

Mr. Hill: As to the matter of trouble with obstructions in the syphon. Of course the object of using two pipes was to crowd one of them, that is, use one at a time, and force the sewage through that under pressure: and if one pipe became stopped at any time, they would have another to fall back on. I was also interested to know whether on the east side sewer there had been any difficulty with obstruction there? That is a very low grade and the amount of sewage rather small: and I would like to ask Mr. Gregory if they carried out the arrangements for flushing at that particular end?

Mr. Gregory: No, they have not. They have never had any trouble, however, from this sewer. It seems to work very well indeed. And as far as flushing arrangements, why I guess the thing has been dropped for the present. The water company are afraid they haven't quite enough water, and they are stopping the use of water.

Secretary Jackson: I would like to ask Mr. Gregory if he got any line on the amount of seepage of ground water?

Mr. Gregory: No, I don't know as we have. When the east side sewer was completed, it was about 10,500 feet long, and the seepage from ground water was running about half to three-quarters of an inch in depth at the end of this 12-inch pipe.

Mr. [illegible]: I think Mr. McKenzie asked the question whether they had any storage tanks. I think the system is designed so a storage tank can be inserted at the outlet on Grass Island in case it ever becomes necessary. That is my recollection of the way the plans were made originally.

Mr. Gregory: Yes, that is true. The sewer was designed so in case we have to, they could put a storage tank on Grass Island to discharge at high tide or when the tide was ebbing.

Mr. Minor's Paper.

Mr. [illegible]: I would like to ask Mr. Minor about the face of the arches, especially the arch under the Air Line Railroad, what stone in that facing was used?

Mr. Minor: The same seam stones that were used for the main part of the arch. There is no difference in the facing [illegible] was a mixture of half-inch to three-quarter [illegible] our very best to get a mixture [illegible]

Mr. Burt: I would like to ask Mr. Minor if he made any calculation as to the additional strength as given by reinforcing of that full center arch?

Mr. Minor: The additional strength?

Mr. Burt: The additional strength that is given by the reinforcing of that full center arch? The arch itself is two feet thick at the crown, and whether a little more thickness there would not be all-sufficient to carry any load of any train or anything else?

Mr. Minor: I think the reinforcing at the crown of the arch was not put in to make up for any lack of depth, but from the fact that the arch was built through a railroad embankment, and no dependence was placed upon the pressure of the filling back of the arch, and it was very close to the railroad, where trains run at a high rate of speed in order to get up the grade at the opposite side. The chief purpose of that reinforcement was to take the thrust of the arch. The loads assumed were very heavy, and it seemed that the abutments would not be thick enough to take the thrust of the arch, and these tie-rods going through horizontally do make it very much stronger. The loading assumed, according to my recollection, was one ton to the square foot.

Mr. Kellogg's Paper.

Mr. Ferry: I would like to ask Mr. Kellogg what advantage there was in building this parallel sewer, instead of the old-fashioned way of having a bell mouth? In the paper I see it says it was considered inadvisable to build, apparently from the reason that the old sewer was in poor condition. Couldn't that old sewer have been reinforced and a bell-mouth put in in the ordinary way with very much less expense than by building this parallel sewer?

Mr. Kellogg: The matter was discussed and figured out, and if we had had only one point at which we wished to tap the old sewer, that is at Chestnut Street, we probably would have reinforced the old sewer and put a dam in. But we had to go beyond to Franklin Street, so I designed this way of doing it. It figured out fully as cheap as it would be to put in a dam, and I thought at the time it would be quite a little cheaper. Another thing: I didn't wish to obstruct the highway travel any more than was necessary. If we had gone to work and reinforced the other work at the two places, it would have taken a long time, and we would have had to take up the two tracks, and that would have made a bad business all around. I don't say that my friendship for the general manager of the street railway was what led me to do it, but I had just as soon he would think so.

MR. FERRY: Is it calculated to make any more of these connections between the sewers any time in the future? I see the area of pipes is about equal to the area of the sewer, but of course the carrying capacity of the cross-cut pipes is only about half the carrying capacity at any given head. Did you contemplate increasing these overflows?

MR. KELLOGG: No, I think the total area of intake is sufficient. These connecting pipes, so far as I figured at the time, seemed to be all the relief that would be needed at that locality. The overflow was made large to take away the water rapidly: water can bore its own hole through water.

MR. JACKSON'S PAPER.

MR. [illegible]: Mr. President, Mr. Jackson has given us a very interesting paper and a very interesting comparison of the results of different systems, but there is one point that he [illegible] which it seems to me might be made a little more [illegible], and that is the [illegible] of the efficiency of the main [illegible] sewers resulting from the various storm overflows. The city of New [illegible] is [illegible] for a combined system [illegible] River on the [illegible] Quinnipiac [illegible] and Mill River through [illegible] overflows for the storm-water [illegible] the [illegible] was wise [illegible] in building the [illegible] overflows, the ef- [illegible] greatly affected by [illegible] make the efficiency [illegible] storm-water [illegible] of these [illegible] of the advantages [illegible] were designed [illegible] only to carry the sanitary sewage, but also the first wash from the streets, which is as bad as sewage. The horse manure and sweepings from the gutters, etc., is just as bad as the sewage proper. In designing the overflows, the sewers were made very much larger than is necessary to carry the sanitary sewage. Mr. Jackson has shown that very clearly on pages 46-47. The table at the bottom of page 46 in comparison with the table on the top of page 47, would show the relative capacity for the sewage proper and the necessary capacity for the storm water. The capacity necessary to carry the sewage proper may be considered a negligible quantity in designing a combined sewerage system, because it is so very small in comparison with the storm water. I think some of the outlets were calculated to carry about one-quarter of an inch an hour. That, of course, is a very small proportion of what may be expected in a heavy rainfall. By proportioning the outlets in that way a very large amount of money was saved from what would have been necessary to construct the outlets large enough to carry the storm water.

In regard to the Meadow Street outlet, which Mr. Jackson finds is of rather low efficiency; as I recall it when these plans were made—I should say first that the Meadow Street outlet drains the central portion of the city where most of the old sewers were. When Mr. Chesbrough planned the system for New Haven, there was at that time quite a collection of old sewers in the center of the city, and Mr. Chesbrough wished to avoid rebuilding those if possible, on the score of economy. At that time there was quite a large brick sewer in George Street, what they called the old George Street sewer, that was higher than desirable in the new system. At that time the George Street sewer discharged at the foot of Fleet Street, near the present intersection of Water Street and Union Avenue. There was an arm of the sea came up through what is now the railroad terminal, and this sewer discharged there. If I remember, at that time there was a drawbridge across the main track of the New York, New Haven & Hartford Railroad Company; but of course that has all been changed by the construction of the tracks at the terminal. The intention was, I know, at that time to sometime take advantage of a storm-water outfall near that place, that is, to construct a supplementary storm-water sewer in George Street, and cut off a large proportion of the storm water and take it out at that point. Of course, the difficulty of doing that now is very largely increased, but it is possible that some relief might be obtained there, although it would cost much more now than it would then. The main thing I wished to call attention to, was the very important influence on the efficiency of the outlets, of having these provisions for storm-water overflows.

Mr. [illegible]: If the legislature acts in accordance with our request we expect to begin this summer the construction of an overflow by passing under the railroad track in the shortest direction to the water from the corner of State and Water Streets, which will give relief. The Meadow Street sewer is [illegible] at present.

Mr. [illegible]: [illegible] necessary to extend the sewer [illegible] Street [illegible] Street?

Mr. [illegible]: [illegible] consideration now. We [illegible] necessary that [illegible] Street sewer [illegible] conditions. [illegible] occasion [illegible]. Relief has got [illegible] as I understand [illegible] water that comes down and [illegible] Street. [illegible] illustra- [illegible] originally [illegible] larger the expense. [illegible] that time [illegible] and [illegible] than they are now. [illegible] the sewers is [illegible] now why [illegible] been [illegible]

[illegible] much [illegible] have built [illegible] have [illegible]

I think the point Mr. Hill mentioned is brought out, at least I tried to bring it, namely—the importance that these overflows are to the different systems where they can be easily and efficiently installed. As you will see from the diagram, all the main outlets, Meadow, James, East and Poplar Streets, and the Boulevard, lie below the Hawksley-Bazalgette curve; and, as I have mentioned in the text, the addition of the relief outlets brings them almost up to the practice of New York and St. Louis. So, that, as he says, the relief outlets are of almost infinite value to the main outlet. The only outlet that I have mentioned that it not readily susceptible to treatment by that means is the Meadow Street, and, as he suggests, some means of cutting off George Street or Church Street must be devised; as Mr. Kelly says, this matter is now under consideration, but we, as yet, do not know just what method we will adopt.

MR. HILL: Just one other point. I notice Mr. Jackson very properly calls attention to the fact that the Hawksley-Bazalgette and Adams formulas have had their day, they are practically obsolete, but I wish to say that when Mr. Chesbrough designed the sewerage system for New Haven, that was about the best guide that he had. The old Hawksley-Bazalgette formula was purely an empirical formula, and was derived from the experience of English engineers on the discharge of sewers in London and vicinity, and up to that time that was the best that United States engineers had to go by. Since that time the other formulas have come into use. The Kutter formula, of course, is a very general one, and my own notion is that the Kutter formula as modified by the Burkli-Ziegler formula gives as good results as any. The Burkli-Ziegler takes into account the slope of the land and by modifying the Kutter formula by the Burkli-Ziegler formula, it gives very good results. These modifications don't differ for ordinary sized sewers very materially from the results of the old Bazalgette formula.

One point that Mr. Jackson makes, and I think it is good sound sense, is where he refers to the point that no formula may be applied indiscriminately. Of course, every problem of that kind is to be taken up separately, and the conditions are never exactly alike in any two cases. Mr. Jackson has very properly called attention to the fact that you must take the methods that will give the best results in that particular case.

Mr. [illegible] I would like to inquire whether any consideration has been taken of using mechanical means for increasing the flow of the sewer, instead of putting in a separate outfall. As I understand it, the only trouble is in time of storm, the heaviest storm is very apt to come at near high water, at a time when the sewers cannot discharge as much as in ordinary times. Now whether an electric pump or something of that kind could be installed on the Meadow Street outlet which would make the Meadow Street outlet discharge three or four times as much water as it does now, thereby lowering the back water putting in an electric pump working automatically when the water reached a certain height, whether that would be less expense than a separate outlet?

Mr. Jackson I would state in answer to that, that a great deal of our trouble has come when the tide was not high, a good many of these storms have occurred at low tide; and yet the sewers have been flooded and the manhole covers have danced [illegible]

As far as I know there has been no consideration given to the use of mechanical means. I have thought some of it but don't know [illegible] successfully applied. I might [illegible] materially in differ- [illegible] will suffice in Chicago [illegible] remember when [illegible] sewers [illegible] there and from [illegible] their sewers [illegible] liminary calculations, and thought they had taken into consideration all factors that would influence in any way. It was another example where practice and theory did not meet in the end. I don't know whether the Meadow Street outlet could be relieved in that manner or not. I think it is possible.

MR. FERRY: The question would be whether the trouble is with the Meadow Street sewer or further up the street. The Meadow Street sewer only has a grade of one foot in 2,000, and of course the current there necessarily, with that fall, is sluggish.

MR. BURT: I would like to ask whether there is much sediment collects in the sewers here? The grades are quite flat, and especially in high water, I would like to know how much trouble there is in that? And also a question that is perhaps a little more divergent, and that is, if there are any siphons in use here, and if so, how much trouble there is caused with those?

MR. JACKSON: In regard to sediment collecting, I would say, thanks to our system of flushing periodically, the complaints that we have from anything of that nature are very few.

In regard to siphons, I don't know that we have any siphons at all, except two 15-inch iron pipes, I believe in use in Water Street; but Mr. Kelly, Mr. Kellogg, Mr. Ferry, or Mr. Hill could tell you more about them than I, since they built them.

MR. KELLY: Those are not siphons, they are simply pipes put in because of scant room under the tracks. We have no siphons.

MR. HARTE'S PAPER.

MR. HARTE: When this paper was written, the chief attention was paid to details of construction, and matters of organization and administration were simply touched upon. I have learned since its publication through one or two questions that have been asked me, that I am not entirely clear in this matter. The work was carried out with the utmost success, and the entire credit belongs to the engineer in charge of the work, a member of this Society, and one of the foremost construction engineers of to-day, Mr. R. M. Berrian.

The other matter is a matter of the titles of the various subordinate members of the organization. I did not give their official titles at all, but designated them by titles which to my mind best expressed their actual relation to the work. There

R. FERRY: I would like to inquire whether any considera has been taken of using mechanical means for increasin flow of the sewer, instead of putting in a separate outfa I understand it, the only trouble is in time of storm. aviest storm is very apt to come at near high water, a me when the sewers cannot discharge as much as in ordi imes. Now whether an electric pump or something of kind could be installed on the Meadow Street outlet w would make the Meadow Street outlet discharge three or times as much water as it does now, thereby lowering th water—putting in an electric pump working autom when the water reached a certain height, whether that be less expense than a separate outlet?

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As far as I know, there has been no consideratio the use of mechanical means. I have thought so I don't know that it could be successfully applic state in passing that the practice differs very materi ent cities, and it has been found that what will suff will not in New York. In New Orleans, as I re they started to install their new system of sewe very careful automatic gaugings of the canals t those gaugings and calculations they figured the be able to discharge 1.2 cubic feet per acre p sewers as actually built would discharge 1 cu per second. They at that time had not been in all the area which had been considered in culations. As you probably know, the rainfa is very heavy, and falls of about three inch at all unusual, and even for short periods inches an hour. The sewers are discha pumping over the levees into the river. part that I have reference to was put in op that instead of one cubic foot per acre p were discharging *five* cubic feet per acr they had gone over the matter very th s

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has been some criticism of this, and to prevent any misunderstanding, I wish to say here that Mr. Beugler was not officially principal assistant engineer, he was simply second assistant engineer. Mr. Law was third assistant engineer. The writer was not officially an assistant engineer at all. Mr. Meggy, who was described as, and to all intents and purposes, was the chief draughtsman, officially was a draughtsman. But the duties and the responsibilities were as indicated by the titles given in the paper.

Mr. [illegible] The statement on page [illegible] of this paper that the track lies between two and three feet below high tide, suggests a question which is of vital interest and importance to us here in New Haven, and that is, the method of taking care of the water. [illegible] in Boston, for example, compare with the conditions which [illegible] exist in New Haven if [illegible] regard to the matter of soil [illegible] elaborate a [illegible] care [illegible] the water?

[illegible] are very different [illegible] have seen a map [illegible] of and which [illegible] thoroughly [illegible] the exten- [illegible] practically [illegible]

Here in New Haven, however, you have entirely different conditions. The soil is sandy, and allows water to pass through it almost as freely as through a sieve. Further, except at the street crossings, the ground for the most part slopes towards the cut. There is a little brook always flowing down the Northampton cut, at present, and after any considerable rain a second brook flows down the main cut from Osborn Street to meet the other at Grand Avenue, and frequently the present tracks are flooded, too, and occasionally over the head of the rail. With a trackage depressed below mean high water, a normal high tide and a rainstorm occurring together would flood the entire depressed section unless large pumps or similar devices were installed to remove the water.

To protect a depressed trackage here it would be necessary to waterproof the entire area of depression. The difficulties of successfully waterproofing a tunnel for electric cars are many; to provide a waterproofing for a wide open cut, which would not be broken by the hammer-blow action of our big locomotives, is a problem which, so far as I know, has never been solved; in Boston, Nature has provided a magnificent clay dam which completely surrounds the low area.

A DESCRIPTION OF THE NEW PLANT OF THE NEW HAVEN GAS LIGHT CO.

By H. S. Sanford.

At the plant of the New Haven Gas Light Company, the Riter-Conley Manufacturing Company of Pittsburgh are erecting and equipping a new works which will be in operation in the very near future. The following is a general description of the new plant:

The coal storage building, the ground plan of which measures over all 332' 3' x 100', is in the form of a braced arch. The frame work consists of twelve main trusses and columns spaced 25' centres, the ends of the building being "hipped." The side walls are of concrete arched between I-beam columns placed at 5' centres. In each bay between the main columns, two pressed steel brake plates have been placed, which can be removed to give easy access to coal in case of spontaneous combustion. The floor of this building is made up of 12" of concrete on top of [illegible] pine piles 12" diameter, placed 4' centres [illegible] the handling [illegible] is done by means of overhead [illegible] in which the operator travels with the machine [illegible] and the raising and lowering [illegible] buckets [illegible] attached to trolley. Two runways [illegible] extend the entire length of the building. At [illegible] designed [illegible] when not in use. The [illegible] the coal buckets being [illegible] which is being discharged. [illegible] "Brown Patent" type, and are equipped with [illegible] series wound [illegible] The trolleys are designed [illegible] have a capacity [illegible] have a speed for hoisting [illegible] per minute. The speed in [illegible] through the storage [illegible] minute.

Above the roof of the coal storage is a cross dormer, in which is located a cross trolley runway (the man trolley and runway being similar to those in the coal storage), which dormer and runway pass over coke storage building and over coal bins in retort house. On the north side of the coal storage the cross runway extends beyond the building proper for a distance of 50′, in order to enable the trolleys to unload coal which may be received by rail. A concrete pit has been built adjoining the railroad track, into which pit all coal which grab buckets cannot pick up to advantage from cars will be dumped, until sufficient coal has accumulated to fill grab buckets. Coal received in box cars will also be dumped into this pit, to be later transferred to storage. The side walls of the cross dormer consist of 2″ of concrete and expanded metal. A concrete and ferroinclave platform is located in this cross dormer, where any necessary repairs to man trolleys, etc., may be conveniently made. A Brown hoist transfer trolley is arranged in connection with this platform, which trolley is used for transferring the coal storage man trolleys from one runway to the other, and also for handling any part which may need repairs.

Directly under the cross dormer runway in the coal storage building are the coal breakers and concrete well, into which well the coal, after passing through the breakers, falls and from whence it is distributed to retort house coal bins.

To the extreme south of the plant, and running parallel to Chapel street, is located the retort house, which is 75′ 6″x235′ 4″. The frame work consists of sixteen trusses, spanning 73′ 6″ inside, the supporting columns being 42′ 6″ high, and spaced at 15′ 7½″ centers. The side walls of the building are of red brick, the exterior surface being laid in red mortar. At the west end of the building a space 54′ long is divided off from the main portion by a brick partition running to the roof, the lower floors of this space being used as a machine and blacksmith shop. An extra floor is placed in this part of the building, which is used as a men's quarters, and is provided with concrete lockers, shower baths, closets, etc.

Extending along the center of the main portion of the building are the retort benches, which are entirely constructed of fire material. The "gas making" equipment consists of a stack of twelve benches, eight retorts to a bench; the retorts being of the "through" type, and 21′ 9″ long. The main or charging floor runs on either sides of the benches, at a height of 11′ 6″ above the ground floor. On both sides of the benches on this floor (which is of 20″ I-beams, carrying concrete on ferroinclave, paved all with promenade tile) are the tracks which carry the charging and pushing machines; that is, the machines which place the coal in the retorts and push the coke out, after the coal has been carbonized. These tracks extend the entire length of the building (the openings in partition wall being closed with steel doors) and are provided with turn-tables in machine shop end, so that machines may be transferred from one side of the benches to the other.

At the east end of the building are located the coal bins. which are sufficiently high above the charging floor to allow the charging machines to run under them, for the purpose of filling their hoppers with broken coal. These bins have a capacity of 550 tons.

Along either side of the retort benches and parallel to the above mentioned tracks, a coke conveyor is installed, which carries the coke as it is pushed from the retorts to the east end of the building, where it is discharged to a third conveyor, which runs across the building, depositing the coke in a concrete pit, just outside of the building proper, and directly under cross dormer runway, so that coke can be readily transferred to coke storage by means of the man trolley.

Between the retort house and coal storage building, and under the cross dormer, is located the coke storage building. This building consists of a series of five bins which are to hold the different sizes of coke and coke breeze. These bins are made up of 20″ supporting I-beams, the floor above being of 12″ I-beams, the side I-beams being 15″. The sides of storage or bins, as well as partition between the compartments, are of concrete arches between the beams, the floor being of concrete on ferroinclave. Above the bins and below the cross runway is located the coke receiving hopper. The man trolleys deposit coke in this hopper after having picked same from pit at side of retort house. The coke from this hopper is fed into revolving coke screens, which distribute the various sizes of coke into their respective bins. The coke is drawn from storage through a series of cut-off gates, which are placed in the bottom of the various bins.

Below the bins a loading and handling platform extends from the center of the coke storage to a distance of 50′ beyond, and I-beam trolleys are so arranged that bags of coke may be readily distributed, after having been filled. Some of cut-off gates in each compartment are so placed that wagons may be driven under them, and coke discharged directly into wagons.

All foundations throughout the plant are of concrete placed on top of 12″ yellow pine piles, and the entire plant is built of fire-proof material, the only wood used being in the doors and windows.

The roofs of all buildings are of Celadon tile, wired to angle purlins, spaced 13¼″.

All machines and machinery are electrically driven.

The pile and timber dock which is built along the entire water front of the new plant is 420′ 0″ long by 22′ 0″ wide.

In connection with the plant a gas holder of 2,117,000 cubic feet capacity has been erected. It is of the four-lift type, having a diameter of 153′ 2″, and a total height of 165′ 4″.

PROCEEDINGS

OF THE

TWENTY-FIRST ANNUAL MEETING

OF THE

Connecticut Society of Civil Engineers

Held in North Sheffield Hall, New Haven, Conn., February 14 and 15, 1905

FIRST DAY.

President Punderford: Members of the Connecticut Society of Civil Engineers, the meeting will kindly come to order.

As it is now 11.22, I will declare the balloting closed for the election of officers; the tellers, Mr. Verrill and Mr. Palmer, are now counting the ballots and the announcement will be made later.

Our Society to-day embraces all branches of engineering, not only civil engineering, but all branches of engineering: that being the case, I have asked to address this meeting, with a few words of welcome to the city of New Haven, one who has done many kinds of engineering and has uniformly been successful in all the engineering he has done, certainly a very good thing to be able to say of any engineer.

It gives me very great pleasure to introduce the chief executive of the city of New Haven, Mayor Studley.

Mayor Studley: Mr. President and members, I should esteem it indeed a very great compliment that I have been paid, if I were worthy of it. I would rather be an engineer than to be a mayor; some people think that all mayors are bad. We all think that all engineers are good.

There is a Persian proverb which runs something like this: "He who knows not, and knows not that he knows not, is a fool—shun him: he who knows not, and knows that he knows not, is simple—teach him: he who knows, and knows not that he knows, is asleep—wake him: he who knows, and knows that he knows, is wise—follow him." The man who knows, and knows that he knows is the only one who could possibly be a civil engineer.

To-day the problems of life are such that a man must know. I remember one of the criticisms of Gen. McClellan. In criticising a young civil engineer, he said: "He was a splendid engineer, but when he had built a bridge, he didn't dare to cross it." To-day no engineer could succeed who would build a bridge which he wouldn't dare to cross.

The problems of life to-day are entirely different from what they were a century ago. Our cities were laid out with streets too narrow. They had only the crude methods of those days, and did not realize the great future that was to come. They didn't depend upon the civil engineer to any great extent. Most any sort of a road was built through the country to enable the people to haul a few loads of produce. To-day we depend largely upon the engineer for even our food supply. In early times the engineer wasn't needed as much as he is now. At present our food supplies come eventually from the far West. If we only go back to the Civil war, about forty years, the progress which has been made in the world of science is something astounding, and there has probably been more advancement along engineering lines crowded into the last fifty years than has been accomplished in all the ages previous to that time.

I remember down in Tennessee when the government was running a road south as far as the Confederate government would permit, they had to have a special engine for the traffic because it was up grade, up the mountain, and required an unusually heavy engine. The engine was so heavy that when repairs were necessary they didn't dare to take it over the main line to Nashville to be repaired because of the injury it might do to the road bed and the bridges,—they feared the bridges might not be able to sustain it, and the weight of that engine was about forty tons.

I remember that when our Consolidated road had been double tracked, it was believed that all the questions of railroading had been settled forever for this part of New England, and yet since that time more money has been expended under the direction of the engineer in rebuilding that road and improving it than has even been spent before. To-day it is being reëstablished, as it is believed, upon a basis which will render anything unnecessary in the future; but so rapidly does the world progress, and so quickly do the problems which have been solved become old, and new ones arise, that the probabilities are that twenty-five years from now they will again be at work remodelling that road, and the civil engineer have new problems to solve for it. The problems of the earth will never remain solved. The old problems, having served their purposes, will pass away and new ones will come.

There are more things yet to be discovered and developed than we have dreamed of. Who would have thought fifty years ago of the wonderful development which has come from electricity and the possibilities which that has given to the civil engineer. Mountains have been tunnelled, roads have been built over them, bridges have been built which were not dreamed of then, and so it will be in the future. There will always be something for the engineer to do. I suspect that even if the problems of this world had all been solved, and nothing else remained for the civil engineer, a trolley line to the moon might be the next thing—I am sure the engineers would do their part—but whether the capitalists would be willing to undertake the task is a grave question, because, as I understand it, there is only one man in the moon, and

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Bridgeport; Walter S. Morton, New Milford; Michael Nagel, New Haven; William S. Pardee, associate, New Haven; Claudius V. Pendleton, Yantic; Lewis R. Rights, East Haven; Richmond E. Slade, Hartford; John H. Soehrens, Bridgeport; James D. Southworth, New Haven; John M. Sullivan, New Haven; John F. Trumbull, New Haven; Albert M. Turner, New Haven. The arrearages of several members were considered. Those present were: President Punderford, Messrs. Kellogg, Graves and Crandall.

At a meeting held in President Punderford's office, Malley Building, New Haven, at 2.15 P. M., of December 16, 1904, it was voted to hold the twenty-first annual meeting at New Haven, that it be a two days' session, and that the arrangements be left to a committee to be appointed by the President. That the Committee be authorized to expend a sum not exceeding $130 from the treasury of the Society. That the Secretary write Messrs. Corson, Sperry and Cheney requesting them to contribute papers. That next meeting of the Board be on January 6, 1905. The arrearage in dues of several members was considered. Those present were: President Punderford, Messrs. Kellogg, Ford and Crandall.

At a meeting held in President Punderford's office, January 6, 1905, President Punderford, Messrs. Ford, Spencer, Crandall and Kellogg being present, the ballot for nominations for officers for the year 1905 was canvassed, with results as published. It was voted to count all ballots received up to January 6, that Secretary notify candidates of their nomination.

Signed,

J. K. PUNDERFORD,
EDWIN D. GRAVES,
H. J. KELLOGG,
FREDERICK L. FORD,
GEORGE K. CRANDALL,
W. T. SPENCER,
Board of Direction.

Attest:

J. FREDERICK JACKSON, *Secretary.*

It was moved and seconded that the report of the Board of Direction be accepted and printed in the annual report.

Next on our program is the report of the Secretary.

REPORT OF THE SECRETARY FOR THE YEAR ENDING FEBRUARY 13, 1905.

To the Officers and Members of the Connecticut Society of Civil Engineers:

Your Secretary respectfully submits the following report for the year past:

In May twelve hundred copies of the Twentieth Annual Proceedings were printed and distributed to the members, to those societies with whom we exchange and to different libraries and institutions of learning. It was deemed advisable to withhold the different exchanges until the issue of the Proceedings, and to send them all by express, thus effecting a considerable saving. One new exchange has been added to our list, The Proceedings of the Engineering Association of the South; we trust that it has met the approval of the members.

The Society held two additional meetings during the year, one at New Haven, on August 10th, and the other at Hartford on November 10th; both were greatly enjoyed by a large representation of the Society.

The Secretary has during the year attended the different meetings of the Board of Direction, has had printed and distributed notices for the different meetings, the bills for dues and advertising and the ballots for nomination and election of officers. The experience with the nominating ballot has not been altogether satisfactory, due partly to lack of understanding and in part to lack of initiative. Those who wanted it the most availed themselves of it the least.

It is now ten years since a general index of the Proceedings of the Society has been compiled, and the Secretary would recommend some action be taken towards preparing one.

During the year twenty-four new members have been elected, twenty-three active, one associate.

SUMMARY FOR THE YEAR.

	[illegible]	[illegible]	ADDITIONS			LOSSES		
			Transfers.	Elected.	Reinst.	Resigned.	Transfers.	Dropped.
Honorary	[illegible]					[illegible]	[illegible]	[illegible]
Active	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]
Associate	[illegible]	[illegible]					[illegible]	[illegible]
Totals	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]

Report accepted.

[illegible]

[illegible] Connecticut Society of [illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
	[illegible]

DISBURSEMENTS.

By Cartage	$ 3.50
" Expressage	60.63
" Freight	9.48
" Expenses Annual Meeting	323.45
" Postage	2.88
" Printing, stationery and supplies	698.78
" Rent of P. O. box	4.00
" Rent of room for meetings	17.00
" Engraving	12.91
" Stenographer's services	42.85
" Stereopticon	7.00
" Traveling expenses, Secretary	5.44
" Salary, Secretary and Treasurer	100.00
" Refunded for dinner ticket	1.50
" Summer meeting	142.80
" Purchase of one report	905.83
	$2,338.55

The report of the Treasurer accepted.

SECRETARY JACKSON: The following names for membership have been received, have been published ten days in advance, have received the approval of the Board of Direction, and are now before the Society for action. There is one mistake in one name as published in the notice of the meeting, Frank W. Whiton, New Haven. Instead of coming from New Haven, he comes from Hartford.

The action of the Board of Direction is as follows: for active membership they have recommended Leoni W. Robinson, Orson H. Marchant and Edgar Thomas Duncan; for associate membership they have recommended Frank W. Whiton, Henry Solon Graves and Winthrop G. Bushnell.

MR. KELLOGG: Mr. President, if I am in order I would move that we elect Mr. B. A. Hathaway to honorary membership; he is a very old man, and has been an active member for a number of years.

MR. GRAVES: I would like to say that Mr. Hathaway is an old man and I think it would be a very nice thing for us to elect him an honorary member, and in that way relieve him of his dues.

PRESIDENT PUNDERFORD: You understand that being transferred from the active to the honorary class still allows him to retain his right to vote, which is desirable in this case.

Motion passed.

PRESIDENT PUNDERFORD: Gentlemen, at our annual meeting there always comes a time when there isn't anything else to do, and at that time the President usually reads his address. As we are waiting for the committee on the election of officers to report, and as the committee has not got their report ready on the election of new members, there is absolutely nothing else that we can do at present, so I will take this opportunity of reading the President's report, which, gentlemen, I desire to say, not through indifference or neglect, is the shortest report ever written; but because it is of no use for me to recite the different engineering work that has gone on all over the country, because the men here have read it, a great deal of it, more thoroughly than I have; so I will give merely a brief résumé of the work done by the Society in the past year.

MR. PUNDERFORD'S ADDRESS.

Brother Members of the Connecticut Society of Civil Engineers:

We are met here to-day for the twenty-first annual meeting of our Society; a society which has grown from the little band of eighteen which inaugurated this Society in Bridgeport in 1884 to an organization which to-day has two hundred and sixty members on its rolls. Many of these names indicate the standing which the Society has to-day, when one knows that our membership includes the chief engineer of the subway of New York, the chief engineer of the New York, New Haven and Hartford Railroad Company, the city engineers of every city in the State, and many local consulting engineers of the highest standing.

Last year at Hartford we held our first two days' session, and in view of the fact that there was an attendance of sixty on the second day, we have felt justified in continuing the second day's meeting. We have secured nine papers for discussion at to-morrow's meeting, but feel that the members are doing themselves as well as the Society an injustice in not contributing papers more freely and thus putting before the Society some interesting portions of their year's work. At the last annual meeting [illegible] was passed that members should during the year send to the Board of Direction a list of engineering books and that the Board would then take the necessary steps to have the State place these books in the different libraries in the State. Only one such list has been received, and this too late for action by the present Board. [illegible] come from such an effort and [illegible] new Board of Direction the [illegible] of the Society.

During the past year we have held two summer meetings—the first in New [illegible] in August [illegible] heavy rain storm, was attended [illegible] inspection was made of the [illegible] Company, then in process of [illegible] under more favor- [illegible] the members were [illegible] New Haven, where the dinner was held, and [illegible] devices of the [illegible] weather a most enjoyable [illegible]

[illegible] Mr. Graves, an informal [illegible] was made to Hartford [illegible] new bridge, of which Mr. Graves is the engineer, [illegible] members going down into the caisson at pier No. 3, which caisson was at that time under pressure of about thirteen pounds. At noon fifty-six members sat down to a lunch at the Hartford Club, as guests of Mr. McMullen, one of the contractors for the bridge, and afterwards a number visited the office of the Bridge Commission and the Commerce Street loft, where the spans had been planned out, making a most enjoyable day.

We are assembled to-day with the largest representation in the history of the Society, and it behooves us, in electing new members from now on, to be careful that members admitted to the first class are qualified under our by-laws for this class, as otherwise the standing of the Society cannot be maintained at its present high rating among state engineering societies.

This afternoon we will listen to two illustrated papers, which should prove of great interest to all present.

At our banquet this evening, the local committee have in mind nothing but a social session tending to better acquaintance among our members. No set speeches have been prepared, but after the dinner an entertainment has been provided by the committee, which we think will prove amusing, if not instructive, to those present.

We meet again to-morrow morning at North Sheffield Hall at 10 o'clock to listen to nine papers written by members, covering interesting features they have met with in some of their work during the past year. It is earnestly desired that members will avail themselves of this opportunity and ask any such questions as may occur to them after the reading of the papers, as the original intention of the two days' session was to afford members an opportunity to obtain, one from another, the advantage of the broad field of work covered by the total membership. No matter how trivial the question may appear, do not hesitate to ask the writer of the paper his reasons for the method followed, because from these discussions there is no doubt much good will obtain.

At 2 o'clock Wednesday afternoon special cars will be in waiting at the corner of Temple and Chapel Streets to take such members as desire to the new plant of the New Haven Gas Company, and to the filtration plant of the Water Company, and if, as has been suggested, some of the members desire to go over the new Wallingford extension of the local trolley system, an opportunity will be afforded.

At 7.30 to-morrow evening Mr. Knight, the engineer of the Continental Compressed Air Company, will give an illustrated paper on the plant at Norwich, Conn. This plant was visited by some of the members of this Society in the summer of 1901, and it will undoubtedly be interesting to see the development of this plant since that date, and the members are invited by the Engineers' Club of Yale University to listen to this paper.

During this week the New Haven Business Men's Association will hold an exposition in the Second Regiment Armory, which will contain many interesting features. To-night will be Governor's night and many governors and their staffs will be present. To-morrow evening representatives of all the Business Men's Associations in the State will be present, and the New Haven Business Men's Association extends to the members of the Society an invitation to attend on these evenings.

It is unnecessary for me to go into detail any further, as your Secretary's report will cover the ground most fully.

The financial standing of the Society is most satisfactory, there being over $[illegible] in the treasury, with no outstanding bills.

In closing I cannot refrain from saying that with the laymen the standing of the engineer as compared with other professions is not on the plane it should be, when we consider the fact that whether it be in crossing a heavy railroad bridge or in passing through a tunnel, whether that be under a mountain or beneath a river, the public must blindly depend upon the work of the engineer as to the safety of the structure as much as the capitalist in investing his money. The engineering profession has so advanced in recent years in its attainments that it cannot be but a short time before the public realizes the value of the work done by the engineer.

I desire to thank the members of the Society for the cooperation and assistance given me during my term of office, and to congratulate them on the officers they have elected for the ensuing year. The affairs of the Society in such hands cannot fail to be well taken care of, and I relinquish my office as President with the assurance that the next year will be the most successful in the history of the Society.

The Secretary [illegible] made a report of the meeting [illegible]

[illegible] balloting [illegible]

[illegible] of the meeting [illegible]

[illegible]

[illegible] Secretary [illegible]

[illegible] That is [illegible]

[illegible]

sewage in the inland cities. I have no doubt that brother Cairns of Waterbury has loads of such problems on his mind, and I hope that he will tell us about the solution of some of them during the year.

There are very interesting problems relating to transportation. Good rapid transit facilities are a sure index of the prosperity and progress of any community. Show me a place where there are good transportation facilities, and I will show you a prosperous community. Our President, Mr. Punderford, will give you a demonstration to-morrow afternoon of how he is solving some of these problems for the delectation of the inhabitants of New Haven and vicinity, provided, of course, that he gets repaired the armatures he has had burned out recently.

There are also interesting problems relating to new principles of construction, or perhaps I should say new methods of construction, because the principles are old. Brother Sperry has given us a very bold example of that, which he will doubtless explain to you to-morrow.

In the solution of these many and interesting problems I am sure the members of the Connecticut Society of Civil Engineers can be depended on to do their full share.

There are many points that I would like to speak about, but engineers are a busy tribe. Our chairman has laid out for you a large amount of work to be done to-day and to-morrow, and, therefore, I will not encroach upon your time with talk. Engineers are trained to produce results, not to talk. I might add that special training is a very important factor in the development of the successful modern engineer. Mr. Tracy and his colleagues are doing fine work in developing and training young engineers. I do not know but we should charge up to them the loss to the active practice of our profession of a good engineer. I refer to the temporary abstraction from active practice of Mr. Ely Ryder, who has been transferred to the training department of young engineers, but Mr. Ryder can be depended upon to do good work wherever he is, and I believe we will get the results of the work in different form.

I want to ask the earnest and hearty coöperation of the members in trying to make the coming year as successful to the Society as the closing year has been. If we can do that I shall be well pleased. I apologize, gentlemen, for taking more of your time than I ought to have done, and thank you again most heartily for the honor you have done me.

President Punderford: Gentlemen, we come now to miscellaneous business. Anything which you have of interest to the Society should be mentioned, any changes in our by-laws, any amendment to the constitution, or anything, no matter what it may be, comes properly before the meeting at this time.

Mr. Maloney: Mr. President, I move that so much of the Secretary's report as refers to the general index, be referred to the incoming Board of Direction.

Motion seconded by Mr. Ford.

President Punderford: It has been moved and seconded that the portion of the Secretary's report relating to the indexing of past reports of the Society from 1894 to the present time, be referred to the incoming

Board of Direction. Any remarks? We have, you know, gentlemen, quite a little library of our own now, and as it has been growing, it would seem that it might be of assistance to have an index properly prepared.

Mr. Kellogg: Mr. President, does that motion include power to act, or simply referred?

President [illegible]: The motion made was simply to refer it.

Mr. Mahoney: I will make the amendment, with power to act.

The President: Gentlemen, you have heard the motion. It is moved that the matter of indexing the history of the Society up to date be referred to the new Board of Direction, with power to act.

Motion adopted unanimously.

Mr. [illegible]: Mr. President, I would like to put a matter that came up this morning before the Society. I want to know if I am right in my [illegible] of that part of the constitution regarding the counting of votes, as the [illegible] has [illegible] different idea from what I have. I [illegible].

As it stands now, the [illegible] one in the blue one, both [illegible] the Secretary [illegible] handed by him unopened to the tellers. [illegible] secret ballot so far as the tellers are concerned [illegible] that the Secretary should check over the blue [illegible] from the members who are entitled to vote [illegible] those that are not entitled to vote [illegible] the men not [illegible] be handed to the [illegible] the tellers should [illegible] them. This would [illegible]

[illegible]

possible for the tellers to find out how any man voted; but if the Secretary simply opens the blue envelopes, he hasn't any possible chance of knowing the contents of the white ones, and the tellers haven't any possible chance of knowing who voted them. That is my idea, and I don't see how there is any more responsibiblity on the Secretary, as he simply hands them over to the tellers. All he does is to take off that outer covering.

SECRETARY JACKSON: I might state that there is another point in this matter which has occurred to me. At the present time, of course, the office of Secretary and Treasurer is held by one man, but it does not necessarily follow that in the history of this Society it will always be so. There may be a time when there will be a Secretary and there will be a Treasurer, and of course, if there is, Mr. Verrill's suggestion could not be carried out, under the present constitution. The Secretary would not know which envelopes to open, and which not to open, he would have no means of knowing the financial standing of any member, and therefore he could not do as Mr. Verrill says.

As for changing the constitution, I am very much adverse to it. We have been tinkering with this constitution for about four years, and, as far as I can see, while we have made improvements, yet we are far from getting anything perfectly satisfactory, as I have said in the Secretary's report. We thought this year that we had now obtained the best possible solution of nominating and electing our officers, but I find that the nominating ballot has not worked the way that we expected it would. I believe in leaving the constitution and by-laws alone for a year or so, and letting these matters work themselves out. Any way, it doesn't require an amendment to the constitution to do as Mr. Verrill says. It is a simple matter of difference of opinion as to the construction of the constitution as it is.

Now, the Secretary is willing to be governed by the opinion of the Society in this matter. If that opinion is that the Secretary shall open the blue envelopes, that is, all blue envelopes excepting those of the members who are in arrears, and deliver the white envelopes to the tellers together with the blue envelopes and a list of those in arrears, why he will do so, but I don't think that is the solution.

MR. VERRILL: That is entirely my idea. It does not require any change in the constitution, it is simply a matter of interpretation.

There is another point that I did not speak of at first: it takes very nearly double the time in counting the votes, and it is generally just as the meeting is in progress; it delays the meeting, and it takes from two men the pleasure of being present in the meeting. That is the way it works.

MR. A. B. HILL: In regard to that matter, it seems to me that Mr. Verrill's presentation of the case is the proper one, and that, it seems to me, is the proper thing to do. So far as having a separate Secretary and Treasurer is concerned, I don't see as that makes very much difference. The Secretary can find from the Treasurer who are in arrears and who are not; and if the Secretary opens the blue ballots and leaves the others to the tellers, it seems to me that would be doing as the work was intended to be done. That gives you a secret ballot.

As far as changing the constitution is concerned, I do not think there is any occasion to do that. It is just simply a matter of interpretation of the present by-laws, and I hope that that interpretation will be as Mr. Verrill has indicated, by the Secretary opening the blue ballots and presenting the white ballots to the tellers.

PRESIDENT PUNDERFORD: Allow me to read this section of the constitution to you:

"SEC. 3. Each member shall signify his choice of candidates on the ballot and return to the Secretary in two sealed envelopes; the Secretary shall deliver the ballots unopened to the tellers appointed by the presiding officer, the inner one being left entirely blank."

It does not say every envelope, it says ballots, and each is to be enclosed in another envelope, so there is nothing but that can be done under the present constitution. If you don't see fit to have the Secretary open them, if there is any objection to that, why that can be changed. There is an objection, as Mr. Verrill says, to taking two men out of the meeting, but we always can kill that time by the President's speech.

Another way that can be done is that these white envelopes, if you so [illegible], at the meeting of the Board of Directors, be gone right over, the Secretary stating that this man and that man is not in good standing and the Board of Directors acting on them. Then there will be no one [illegible] will not be voted because they are not in good standing. [illegible] the Board of Directors remove such as they have [illegible] and deliver them to the Secretary. [illegible] them to the tellers. Now [illegible] some of the work [illegible] I can see no objection.

[illegible] that we send a telegram [illegible] of this Society. [illegible]

[illegible] of the Directors [illegible] annual meeting send [illegible]

[illegible]

[illegible] any change [illegible] of the [illegible] the rules and [illegible] the Board of Directors [illegible]

THE PRESIDENT: Gentlemen, we have plenty of time for any other matters which you think advisable to bring up. We have more time now than we will have during any other portion of the two days' session.

MR. TRACY: Mr. Chairman, I don't want to delay proceedings, but, as you say, we have a minute or two, and I have a matter I should like to bring up.

In comparing our proceedings with the proceedings of other societies, it seems to me we cannot help but notice that there is a great deal in ours which is not in the others. I think, for example, that the discussion which has just taken place should be boiled down to half a dozen sentences, instead of being reported word for word. It seems to me also, that oftentimes it is not desirable that everything that a man says in one of our meetings should be reported. I know that in some cases members feel restrained in what they say by the fact that it is going to be printed, although we are perfectly willing to talk among ourselves. But in view of the fact that it is going all over the country, much of what we say seems to me too trivial to be printed. I think that is a matter which the Board of Direction might consider. They can make an improvement along that line.

THE PRESIDENT: I think possibly, Mr. Tracy, that the incoming President and Secretary can edit this informal talk out. I think it might be a very good thing, and I don't see that there is any motion necessary to authorize them to do that, because we have nothing in our by-laws saying that we shall print every word of discussion that might arise here. I think possibly it might be well to have some of this talk edited out.

MR. BURT: Mr. President, there is one point I wish to bring up, and that is, under our system of selection, it does not appear, when a person is voted for or nominated, and has declined,—his declination does not appear in any place. And it seems to me as though there ought to be some means of having it appear, where there is a person who is a popular candidate, and would, unless he declined the office, receive a majority or a large number of the votes—it would appear as though that ought to appear in some way.

THE PRESIDENT: Personally, I understand you fully, and I think it has some very bad features, inasmuch as a person might feel restrained against accepting a nomination at the hands of the Society if that nomination came down the line four or five miles to him. If a man does not take sufficient interest in the Society to stand for his nomination, or has not the courage to fight it through, I don't believe the Society owes him the publication of it. That is merely my personal view. It might operate very seriously to the disadvantage of some possible candidate, and had he the notion that there were several other candidates nominated at the same time, everybody receiving over ten votes being nominated, unless he received more than ten for some other office, I think it might take away a little from the pleasure of the man receiving the nomination. If the other fellow has not got the nerve to run, or a sufficient interest in the Society to run, I don't think the

Society owes him a pat on the back. It is up to you, gentlemen, to decide.

MR. WADHAMS: I would simply like to inquire whether, when nominations are made, if it is not necessary to print the name of every man that receives over ten, whether he desires to accept or not. It seems to me that the time for him to say whether he would accept or not would be after receiving the election.

THE PRESIDENT: Under our by-laws we are supposed to notify them immediately after their nomination, and if they don't notify us of their declination immediately, or reasonably soon thereafter, it is reasonably safe to assume that they stand for the office. This system of voting was merely to eliminate that long-drawn out discussion and balloting at the meeting. This year there happened to be a peculiar unanimity, so that there was no contest. But it is very unlikely that this will happen again. There will probably be several nominated, because anyone receiving over ten ballots, unless he receives more than that for some other office, is nominated. If no one receives ten ballots for any one office, then the Board of Direction nominates at least two, and sends out their names. This was our first experiment with this system, and the way it has worked I don't think will happen again. Now if you desire to bring that before the meeting in the form of a motion, why I should be very glad to entertain it.

MR. R[illegible]: I want to say I believe there are good and sufficient reasons why a person would not accept an office. He might have every reason and desire to do so and yet not be able to do it practically. That is the reason [illegible] the fact that he had received certain votes ought to appear.

[illegible] say something to us [illegible]

[illegible] I don't see any reason why [illegible] nomination. He is notified [illegible] he wants to [illegible]

[illegible] be advisable [illegible] name.

[illegible] manner [illegible] put at them [illegible] different numbers [illegible]

[illegible] that the nomina- [illegible] start, for the [illegible]

[illegible] when [illegible] that the meeting [illegible]

AFTERNOON SESSION, TUESDAY, FEBRUARY 14TH.

The President: Gentlemen, the meeting will please come to order. The first paper will be a description of the new plant of the Hartford Electric Light Company at Dutch Point, Hartford, Conn. The first portion of this paper will be given by Mr. Francis, the civil engineer of Westinghouse, Church, Kerr & Co.

Mr. Francis happens to have been born near Hartford, and comes back to tell us something about it.

Gentlemen, I take great pleasure in introducing to you Mr. George B. Francis.

Mr. George B. Francis: Mr. President and members of the Connecticut Society of Civil Engineers, I wish to say for Mr. Kent and myself that we take pleasure in being with you this afternoon, in making your acquaintance, and partaking of your hospitality.

The paper which we present will record some unusual conditions found in the strata upon which the plant to be described is located, as well as a description of the plant itself.

Mr. Francis' paper appears on page 86.

President Punderford: Gentlemen, the balance of the paper will be carried forward to its end by the Company's mechanical engineer. I take pleasure in introducing Mr. Henry R. Kent. (Page 93.)

President Punderford: Gentlemen, are there any questions that you would like to ask of Mr. Francis or Mr. Kent? If there are any, they say that they will be very glad to answer them. If there are no questions, I desire to make a short statement regarding our next paper.

About two months ago, as a member of the New England Street Railway Club, I received a circular about the proceedings of the New England Society in Boston. This paper indicated that a lecture would be given on street railway special track work by Mr. Angerer. Thinking this paper might be of interest to the Society, I made a special trip to Boston to hear the paper, and after hearing it I was impressed with the importance of obtaining it for the Society. I spoke to Mr. Angerer, inviting him to come here and give the paper. He said he was in no manner a lecturer, but a busy commercial man, and was very loath to come. I finally persuaded him of the great favor he would do me, as well as the Society, if he would come, and therefore we have him with us to-day.

This paper deals with the different periods of advancement in street railway special track work, and also covers somewhat steam railroad work. The paper has been re-written since it was delivered before the New England Society, so you are not hearing a second-hand paper.

As the President of the Society, and especially as a Yale graduate, I invite graduates or undergraduates who are here, and not only invite, but urge them to wait and hear Mr. Angerer's paper. It is entirely devoid of any technical work, and no matter if you haven't been here but a year, it will appeal to you very greatly I am sure, and prove of quite a little interest and great benefit to you.

Gentlemen, I take great pleasure in introducing to you Mr. Victor Angerer, Vice President and General Manager of the William Wharton, Junior, & Co., who will read a paper on the development of special track work on street railways, and its influences on track work of steam railroads.

Mr Victor Angerer: Mr. President and gentlemen, allow me to remark that, in response to the words of your President, I was not loath to come here. On the contrary, it gives me great pleasure to be here to-night I was only loath to repeat a paper, and therefore concluded afterwards to re-write it to some extent, although, in the main part, it is what I have already said in Boston a month ago, but I still hope it will be of interest to you It deals with specialty in track work in engineering

Mr Angerer's paper appears on page 107.

President Pendergrass: Gentlemen, I think I voice the sentiment of the Society and our guests in saying that we owe a deep debt of gratitude to the gentlemen who have given us their time and their experience this afternoon I can only say that I trust this evening that, as our guests, they will dine with us and enjoy the feats of legerdemain and juggling as much as we have enjoyed their discussion this afternoon.

If there are any points that the members desire to ask Mr. Angerer about I am sure he will be pleased to answer you. He has covered the ground so thoroughly I doubt if any room remains for questions If there are no questions I sincerely trust that your local committee's work in endeavoring to provide a pleasant evening will meet with the reward of having [illegible] this evening at our dinner

[illegible] engineers who are so widely [illegible] in a social way, that [illegible] informal manner we [illegible] remain for the banquet [illegible] they will.

[illegible] Business Men's Exposition [illegible] about 11 o'clock as a [illegible] will [illegible] the [illegible] during the week.

[illegible]

ANNUAL BANQUET.

Engineering talk was tabooed at the banquet last evening at Heublein's Cafe. As ex-President John K. Punderford expressed it, "Throw anything at the man who talks engineering."

Ninety members of the society gathered to spend a jolly evening in uniting old friendships and enjoying dinner together. The menu was served in the banquet hall on the second floor, and was as follows:

Cocktail.
Blue Points on Half Shell.
Celery. Spanish Olives.
Mock Turtle Soup.
Broiled Shad. Creamed Potatoes.
Filet of Beef with Mushroom Sauce.
Green Peas.
Punch.
Roast Philadelphia Capons.
Cranberry Sauce. Julienne Potatoes.
Lettuce Salad.
Ice Cream. Cakes.
Roquefort Cheese. Crackers.
Coffee.
Cigars. Cigarettes.

During the repast considerable commotion attended the appearance of Count Kreiger, bag and baggage, accompanied by his assistant, Youmar. "They looked as though they had just come over the Wallingford extension," shouted someone, but Mr Punderford announced that he would make it all right. "The Count will not perform until he has had a ball."

During the time intervening between the last course and the appearance of Kreiger, Mr. Punderford, who was master of ceremonies, introduced the several speakers. The men were selected at random and no set speeches were made. He called upon Henry J. Kellogg, "one of the originators of the bunch; the bunch is all right, but let's hear from the originator."

Mr. Kellogg said in part: "When Mr. Punderford has the trolley tracks all cleared of snow and all the cars running—('when!' shouted some one in the rear); after the applause Mr. Kellogg proceeded. "And has no local committee waiting on him, he comes over and calls on me and I stand it because John smokes good cigars, you know."

Brother Morton was then asked to speak in defense of his assuming to wear the "glad rags." Mr. Morton delivered Mr. Corson's speech.

When William R. C. Corson was himself called to the floor, he said: "I did not tell Morton to make any such speech as that." He then recited in dialogue, "Maloney's Brindle Cat," which drew great applause.

Edwin D. Graves of Hartford then expressed the appreciation and thanks of the visiting members for the excellent occasion afforded them and for the efforts of the New Haven members in their behalf.

Mr. William Sperry then sang "Good Bye, My Blue Bell," accompanied by the piano from the Holt orchestra, which was present. A storm of applause greeted Mr. Sperry as he sat down, and as an encore he sang, "Up in a Cocoanut Tree."

At this juncture the speech-making was cut short by the announcement from Mr. Punderford: "Gentlemen, you may look, but must not handle."

The Count Kreiger of New York, and Youmar, the Oriental juggler, had appeared. At first the boys were inclined to guy the old gentleman, with the German accent and long hair, but he had not operated for their benefit with a pack of cards for more than two minutes when the house was his to a man. His card tricks were beyond all fathoming and when he made things disappear men began holding on to their watches and money. Youmar was right there with all the goods, and both men were given much applause and praise for their very clever work. The evening's program closed with the departure of the count and the members left the hall wondering how he did it.

Among those present were: William R. C. Carson, Hartford; F. H. Ellsworth, New Haven; F. G. Snell, Hartford; Charles M. Crawford, Hartford; George H. McLean, New Haven; Charles Rufus Harte, New Haven; W. D. Morton, Hartford; G. E. Verrill, New Haven; Paul Nash, Stamford; Frederick H. Parsons, New York City; George E. [illegible], New Haven; Edward E. [illegible], New Haven; Charles F. Chase, New Britain; W. T. Spencer, New Haven; F. L. Ford, Hartford; [illegible] Frederick [illegible], New Haven; Edwin D. Graves, Hartford; [illegible] D. [illegible], New [illegible]; [illegible] A. Sullivan, Jr., New Haven; Walter A. [illegible], New [illegible]; [illegible] F. Trumbull, New Haven; C. H. [illegible]; [illegible] George H. Sage, Hartford; George R. [illegible], New York; [illegible] Kent, New York; Frank N. [illegible] Williams, [illegible]ington; Edward J. Rangee, New [illegible]; Charles N. Wood, Norwalk; [illegible] Stevens, Bridgeport; Walter [illegible], New Haven; Max E. Miller, New [illegible]; [illegible] F. Gilbert, New [illegible]; Walter [illegible] Brown, Springfield; [illegible] F. [illegible], New Haven; [illegible], New Haven; [illegible] H. Berry, New [illegible] M. Knight, New [illegible] F. Hill, New Haven.

[illegible] as follows:

[illegible] Adams, Francis A. [illegible] Frederick [illegible] William Sperry, Charles [illegible] Walter T. Spencer and [illegible] N. [illegible]

MORNING SESSION, WEDNESDAY, FEBRUARY 15TH, 1905.

President Punderford: Gentlemen, the meeting will please come to order. Before hearing any of these papers, I desire to correct an omission on my part yesterday in forgetting to mention to the members of the Society the work that has been done by the Assistant Secretary. He has been of the very greatest assistance to me during the past year. Mr. Ryder has spent a great deal of time in securing advertisements for our publication, without which our financial standing would not be as good as it is to-day. He has assisted me very greatly in every way possible, and I desire to take this time to thank him most kindly for his efforts.

Is there any business, gentlemen, which was not finished at yesterday's meeting which you desire to take up this morning before going into the reading and discussion of these papers?

Mr. Kellogg: Mr. President, if I am in order, and if it is a proper time, I would like to move a vote of thanks to Messrs. Francis and Kent, who were interested in the first paper, and Mr. Victor Angerer, on street railway work, for their kindness in coming here, and our appreciation of the excellent papers which they delivered, and that the Secretary be requested to put this motion in writing to that effect.

Motion seconded by Mr. Hill.

Motion adopted unanimously.

Mr. Morton: Mr. President, I wish to call the attention of the Society to what struck me from my own personal experience, as something which perhaps might increase the membership and be of benefit, and that is, the modification of the present method of electing members. According to the constitution, applications for membership must be made twenty-one days before a meeting of the Society. The only meeting that is authorized, the only regular meeting, is the annual meeting once a year, which means that you can elect members once a year. Practically this has been cut in two by the summer meeting, so that now you can elect a member every six months, provided his application is in twenty-one days before that meeting. It strikes me that that is a long wait for a man who desires to get into the Society, and sometimes you forget that you must apply just twenty-one days before. I know, in my own experience, I applied for membership a year ago, and I was elected some time in August. Perhaps in my case it was a very worthy delay, but I had an experience when I made an application for my friend, Mr. Crawford, a man I thought a desirable member of the Society; he is an engineer and general manager of the Central New England Railroad Company, a very busy man. He signed the application, and I believe it is now reposing on his desk. He forgot to put it in twenty-one days before the meeting, and he naturally forgot to tell me to put it in. I also understand that it takes a year, or in case of the summer meeting half a year, to change this constitution. Now if you are to change the method of electing members, it is not a thing to be [illegible] member [illegible] a [illegible]

[illegible] a sufficient memorandum [illegible] to pick and choose, and in so doing we can appreciate the value of the Society a great deal, and in that manner only.

SECRETARY JACKSON: Mr. President, I would like to speak on this matter. As I understand Mr. Morton's idea, this resolution, as presented, is to go into effect at a special meeting to be called by the Board of Direction. Now, in order that that amendment may go into effect at any meeting intervening between this one and the next annual meeting, it is necessary, according to the constitution, that the committee present an amendment in writing at this meeting, and that it be discussed, before action can be taken on it at the next meeting.

PRESIDENT PUNDERFORD: I take it upon myself to say, because I had a slight talk on that subject explaining that point, and Mr. Morton said he didn't care to draw that up to-day hastily, knowing that it should be signed by three members and read and discussed and then sent out, and then voted upon, but he desired that it be given more time, greater consideration than he had time to give to it to-day. That was your idea, Mr. Morton?

MR. MORTON: Yes.

THE PRESIDENT: So he asks merely to refer this to the Board of Direction, who will act as a committee to draw this amendment and submit it to the first meeting, when you will have an opportunity for discussion, and at the next meeting it will then be voted upon according to our by-laws.

SECRETARY JACKSON: Is that your idea, Mr. Morton?

MR. MORTON: Yes, I think that is the only way it can be done.

THE PRESIDENT: He don't desire to draw that to-day, because he hasn't given it sufficient thought.

Motion adopted unanimously.

THE PRESIDENT: If there is no other business, gentlemen, we will proceed to the reading of these papers and the discussion of the same. I say discussion, and I sincerely trust that there will be discussion. You haven't come here to-day to sit here like a lot of stotenbottles, and hear these papers read, and then run away without saying anything. You are to ask any question that seems of interest to you, or on any points that will possibly arise from these papers; because some other bashful friend may be sitting alongside of you and might wish to ask that question, but thinks it is too trivial. Any man that has the nerve to ask the question should ask it, because he may be asking the very question that his bashful friend next to him desires to ask.

MR. A. B. HILL: Before you take up the discussion of the papers, I would like to make one motion, and that is that the Secretary be requested to present a vote of thanks to the Faculty of the Sheffield Scientific School for the courtesies they have shown us.

Motion seconded by Mr. Daboll.

Motion adopted unanimously.

MR. A. B. HILL: It occurs to me that there is one other point; I noticed in reading over the minutes of the last annual meeting that the President appoints an Assistant Secretary. If I may have that privilege, I would like to re-appoint Mr. Ely M. T. Ryder.

THE PRESIDENT: You could not do better. That is not necessary as a motion. This is merely an evidence of the President's good judgment. Mr. Charles A. Ferry's paper on the New Haven Filtration Plant, having been read at the previous meeting, with your permission, we will omit the reading of Mr. Ferry's paper at the present time. I ask you to open the proceedings by a discussion of Mr. Ferry's paper. Mr. Hill, will you not start this ball rolling please?

Discussion will be found on page 136.

THE PRESIDENT: There is one paper which was received too late for publication in the bulletin through a misapprehension. The writer did not realize that we were going to press at the time we did, and therefore that paper has not been printed. In order to make sure that every one receives that paper at this meeting, I would ask Mr. Edward H. Everit to read his paper on telephone engineering. Mr. Everit has been hoping that the meeting would be delayed so long that he wouldn't be called on.

Mr. Everit's paper appears on page 75.

THE PRESIDENT: If there are no other questions, I will ask Mr. Gregory to read his paper on the Greenwich Sewer System.

Mr. Gregory's paper appears on page 20.

THE PRESIDENT: Gentlemen, are there any questions that you would like to ask?

THE PRESIDENT: As the [illegible] is getting so late, we will omit the reading [illegible] that you may be able [illegible] that [illegible] may desire.

[illegible]

Mr. Corson: Before we adjourn, I should like to express to you, and I think the whole society will join with me, in an expression of appreciation to the retiring president and the officers of the committee who have had this meeting in charge. We have all of us had a very good time and I would like to move a vote of thanks to the officers and the committee.

Mr. Graves: I would like to second that motion. I have had that in mind, and it just exactly voices my sentiments.

The President: It has been moved and seconded that a motion as made by Brother Corson be adopted, and that a vote of thanks be given to the local officers and committee for the arrangements made for this meeting.

Motion adopted unanimously.

Meeting adjourned.

After lunch the members took cars and visited the Filtration Plant and the works of the Gas Light Company. The trip to Wallingford was omitted.

In the evening the members gathered in North Sheffield Hall and listened to Mr. Knight's paper on the Continental Compressed Air Company plant at Norwich, Conn.

SUMMER MEETING.

The Summer meeting held at New Haven, August 10, was attended by about one hundred members of the Society. The meeting was called to order by President Punderford in North Sheffield Hall at 10.30 A. M. Reading of minutes of previous meeting omitted; they having been printed in Annual Proceedings. The following new members were elected: William H. Barker, Hartford; Charles H. Berry, Jr., New Haven; Clarence M. Blair, New Haven; Clinton T. Bissell, Brooklyn, N. Y.; William J. Blatchley, New Haven; Thomas C. Brett, New Haven; Lewis B. Comstock, Bridgeport; Orrin F. Cooley, Springfield, Mass.; J. Louis Gregory, Greenwich; Charles R. Hart, New Haven; Samuel Higgins, New Haven; Harry T. Kehr, New Haven; Walter H. Law, Bridgeport; Walter S. Morton, New Milford; Michael Nagel, New Haven; William S. Pardee, associate, New Haven; Claudius V. Pendleton, Yantic; Lewis R. Rights, East Haven; Richmond E. Slade, Hartford; John H. Soehrens, Bridgeport; James D. Southworth, New Haven; John M. Sullivan, New Haven; John F. Trumbull, New Haven; Albert M. Turner, New Haven.

Mr. Chas. A. Ferry then read a paper on The New Haven Filtration Plant, which appears on page 1 of this report.

A vote of thanks was extended to Mr. Ferry.

The members then took cars, which were furnished through courtesy of the Consolidated Railway Company, to the site of the works, where the plant was inspected. At the works a lunch provided by the New Haven members for their guests was partaken of. The members then took cars to the plant of the New Haven Gas Light Company, where the different features were explained by President Nettleton and Mr. H. S. Sanford, resident engineer for the Riter-Conley Manufacturing Company, designers and builders of the works. They then proceeded to Savin Rock, where dinner was served at Moegling's Beach House, after which they enjoyed the hospitality of President Punderford and visited the different amusement features. In spite of the weather, which was abominable, the members voted it one of the best excursions ever held by the Society. Among those present were: A. B. Hill, New Haven; David Daggett, New Haven; Edward Dillon, New Haven; Geo. H. Bishop, Middletown; Edwin D. Graves, Hartford; M. N. Baker, New York; Geo. K. Crandall, New London; Henry J. Kellogg, New Haven; Moses Joy, New Haven; L. W. Burt, Hartford; R. N. Clark, Hartford; John T. Henderson, Hartford; Walter A. Brown, Springfield, Mass.; Henry R. Buck, Hartford; Geo. E. Smith, Derby; Howard F. White, New Haven; Alexander Cahn, New Haven; A. William Sperry, New Haven; G. E. Verrill, New Haven; F. S. Luther, Hartford; J. F. Knight, Ellington; Ernest W. Wiggin, New Haven; W. F. Spencer, New Haven; F. J. Rungee, New Haven; J. D. Southworth, New Haven; C. H. Berry, New Haven; Emil C. Buscher, Central Valley, N. Y.; D. F. Brinsmade, Derby; Nathan Cheney, Cambridge, Mass.; Eli Whitney, New Haven.

On November 10, about sixty members, in response to an invitation from Mr. Edwin D. Graves, chief engineer, visited the site of the new bridge across the Connecticut river at Hartford. They assembled at the bridge at 10.30 A. M. [illegible] and houses, descended [illegible] No. 3 [illegible] reached rock and where [illegible] excellent [illegible]

[illegible]

[illegible] Middletown [illegible] R. N. Clark, Hartford [illegible] New Haven; John W. [illegible] McKenna [illegible] ington; J. C. Tracy, New Haven: C. H. Bunce, Hartford; G. E. Verrill, New Haven; George W. Freeman, New London; J. Frederick Jackson, New Haven; Edwin D. Graves, Hartford; C. W. Eddy, Thomaston; A. Clark Hall, Hartford; J. T. Shaughnessy, Hartford; J. T. McKnight, Rockville; George E. Manning, New London; Shepard B. Palmer, Norwich; G. A. Parker, Hartford; Raymond F. Bennett, Portland, Me.; J. D. Southworth, New Haven; John F. Trumbull, New Haven; Charles S. Farnham, New Haven; Walter S. Morton, Charles M. Crawford, T. C. B. Snell, J. W. Phelps, M. H. West, E. T. Duncan, James B. Thomas, H. G. Clark, R. E. Slade, Henry R. Buck, Edwin J. Jones, all of Hartford; A. H. Terry, New Haven: C. H. Berry, New Haven; John H. Wickersham, Edward M. Stone, L. W. Burt, H. K. Lee, John T. Henderson, all of Hartford.

List of Members.

With Addresses and Dates of Election.

Members are particularly requested to inform the Secretary at once of any change in address.

HONORARY MEMBERS.

CHITTENDEN, PROF. RUSSELL H. ....April 20, 1901
Dean of Sheffield Scientific School of Yale University, New Haven, Conn.

CLARK, EDGAR ....June, 1887
Putnam, Conn.

CLARK, JOHN E. ....April, 1884
Prof. Mathematics, Emeritus, at Sheffield Scientific School, Yale University,
South Terrace, Longmeadow, Mass.

FITZGERALD, DESMOND ....Jan. 8, 1901
Engineer Sudbury Division, Metropolitan Water Board,
Brookline, Mass.

FROST, GEORGE H. ....April, 1884
President Engineering News Publishing Co., New York.

HADLEY, DR. ARTHUR T. ....April 20, 1901
President Yale University, New Haven, Conn.

HATHAWAY, BENJAMIN F. ....Aug. 14, 1900
Stamford, Conn.

HAYNES, EDWARD C. ....Jan. 14, 1890
Danbury, N. H.

HULL, BRADLEY B. ....April, 1884
Bridgeport, Conn.

PETTEE, WILLIAM I. ....Jan. 10, 1899
Civil Engineer, Salisbury, Conn.

SEYMOUR, WILLIAM G. ....Feb. 6, 1904
Railroad Commissioner, Ridgefield, Conn.

SKINNER, FRANK W. ....Jan. 6, [illegible]
Editorial Staff of the Engineering Record, New York.

MEMBERS.

ADAMS, ARTHUR A. ....Jan. 6, [illegible]
Superintendent of Streets, Springfield, Mass.

ADAMS, JULIUS I. ....July 16, [illegible]
Civil Engineer Hartford, Manchester and Rockville Tramway Co.,
South Manchester, Conn.

ALDERSON, ALGERNON B. ....Jan. 16, [illegible]
Town Engineer, West Hartford, Conn.

AMRHYN, GUSTAVE X. ....Feb. 4, [illegible]
[illegible], Department of Parks, New Haven, Conn.

AUGUR, EDWIN P. .... April, 1884
Civil Engineer and Surveyor, Middletown, Conn.

AYRES, HENRY W. .... Jan. 13, 1885
Hydraulic Engineer, Hartford, Conn.

BACON, ARTHUR W. .... Feb. 9, 1904
Secretary United States Engineering Co., New York.

BACON, JOHN W. .... Jan., 1884
Civil Engineer, Danbury, Conn.

BARKER, WILLIAM H. .... Aug. 10, 1904
Jenkins & Barker, Hartford, Conn.

BARNEY, SAMUEL E. .... Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School, Yale University,
New Haven, Conn.

BEACH, CHARLES EDWARD .... Jan. 10, 1893
Civil Engineer, West Hartford, Conn.

BELDEN, CLIFFORD H. .... March 30, 1900
Civil Engineer, Hartford, Conn.

BELDEN, EDGAR T. .... Jan. 8, 1901
Warner-Miller Co., New Haven, Conn.

BENNETT, RAYMOND F. .... March 30, 1900
W. F. Bennett & Son, Contractors, Portland, Maine.

BERRIAN, RICHARD M. .... Jan. 9, 1900
Engineering Department, N. Y., N. H. & H. R. R. Co.,
Bridgeport, Conn.

BERRY, CHARLES H. .... Aug. 10, 1904
Civil Engineer, New Haven, Conn.

BISHOP, GEORGE H. .... Jan. 13, 1885
Hydraulic Engineer, Middletown, Conn.

BISSELL, CLINTON T. .... Aug. 10, 1904
Civil Engineer, Brooklyn, N. Y.

BLAIR, CLARENCE M. .... Aug. 10, 1904
Civil Engineer, New Haven, Conn.

BLAKESLEE, CLARENCE .... Jan. 9, 1900
Civil Engineer and Contractor, New Haven, Conn.

BLATCHLEY, WILLIAM J. .... Aug. 10, 1904
Civil Engineer, New Haven, Conn.

BRADLEY, DANIEL E. .... Jan. 9, 1894
President Berlin Construction Co., Berlin, Conn.

BRETT, THOMAS C. .... Aug. 10, 1904
Secretary Yale Safe & Iron Works, New Haven, Conn.

BRINSMADE, DANIEL E. .... April 20, 1901
Secretary and Assistant Engineer Ousatonic Water Co., Shelton, Conn.

BRINSMADE, D. S. .... April, 1884
Engineer Housatonic Water Power Co., Derby, Conn.

BROWN, CHARLES O. .... Jan. 11, 1898
City Engineer, Danbury, Conn.

BROWN, EDMUND .... Jan. 10, 1899
Superintendent and Engineer of Norfolk Water Co., Norfolk, Conn.

BROWN, WALTER A. .... Oct. 11, 1902
First Assistant City Engineer, Springfield, Mass.

BUCK, HENRY R. .... Jan. 10, 1899
Assistant City Engineer, Hartford, Conn.

BUDDINGTON, JOHN E. .... March 30, 1900
Consulting Engineer and Contractor, New Haven, Conn.

BUNCE, CHARLES H. ....April, 1884
Civil Engineer, Hartford, Conn.

BURT, LUTHER HAROLD ....Aug. 14, 1900
Department of Engineering, Maintenance of Way, Penn. R. R.,
Philadelphia, Pa.

BURT, LUTHER W. ....Jan. 13, 1885
Civil Engineer and Surveyor, Hartford, Conn.

BUSCHOR, EMIL CHARLES ....Jan. 10, 1899
Civil Engineer and Surveyor, Central Valley, New York.

BUSH, EDWARD W. ....Jan. 10, 1899
Assistant Engineer Conn. River Bridge and Highway District,
Hartford, Conn.

BUSHNELL, W. G. ....Feb. 14, 1905
Associate Member, New Haven, Conn. Westinghouse Electric Co.

CADWELL, WILLIAM H. ....May 31, 1893
Civil Engineer, New Britain, Conn.

CAHN, ALEXANDER ....Jan. 9, 1900
Civil Engineer, New Haven, Conn.

CAIRNS, ROBERT A. ....Aug. 29, 1890
Sanitary and Hydraulic Engineer and City Engineer, Waterbury, Conn.

CARD, HUBER D. ....Oct. 24, 1895
Civil Engineer and Surveyor, Willimantic, Conn.

CARLISLE, HARRY F. ....Jan. 9, 1900
S. N. E. Telephone Co., New Haven, Conn.

CARTER, RALPH R. ....Jan. 14, 1890
Civil Engineer, [illegible] Courtlandt St., New York.

CAUM, FRANK ....Aug. 14, 1900
Superintendent Hartford Street Railway, Hartford, Conn.

CHANDLER, CHARLES F. ....April, 1884
Civil Engineer, Norwich, Conn.

CHAPMAN, FREDERICK A. ....Feb. 20, 1903
Civil Engineer, Philippine Islands.

[illegible] ....March [illegible], 1900
Engineer, [illegible] Construction Co., New Britain, Conn.

[illegible] ....Jan. [illegible], [illegible]
Civil Engineer, South Manchester, Conn.

[illegible] ....July 18, 1899
Engineer [illegible], Hartford, Conn.

[illegible] ....July 18, 1899
Civil Engineer [illegible] Public Parks, Hartford, Conn.

[illegible] ....[illegible]
Civil Engineer, [illegible], Conn.

[illegible] ....July [illegible]
Civil Engineer, [illegible], Conn.

[illegible] ....Jan. [illegible]
Civil Engineer, Stamford, Conn.

[illegible] ....Jan. [illegible]
[illegible] Madison Av., New York.

[illegible] ....[illegible]
[illegible] Water Works, New Bedford, Mass.

[illegible] ....[illegible]
Civil Engineer, [illegible], Conn.

[illegible] ....[illegible]
[illegible]

COMSTOCK, LEWIS B. .... Aug. 10, 1904
Civil Engineer, Bridgeport, Conn.

COOLEY, ORRIN F. .... Aug. 10, 1904
Civil Engineer, Springfield, Mass.

CORSON, WILLIAM R. C. .... Feb. 10, 1903
Electrical Engineer, Hartford, Conn.

CRANDALL, GEORGE K. .... Jan. 11, 1887
City Engineer, New London, Conn.

CRAWFORD, CHARLES M. .... July 18, 1899
Secretary Hartford Paving and Construction Co., Hartford, Conn.

CRAWFORD, NORMAN McDONALD .... July 18, 1899
General Manager Hartford Street Railway Co., Hartford, Conn.

CURTIS, FAYETTE S. .... Jan. 9, 1900
Vice President N. Y., N. H. & H. R. R., Boston, Mass.

CURTIS, THEODORE ALLEN .... Aug. 14, 1900
Curtis & Johnson, Hartford, Conn.

DABOLL, LOREN E. .... Jan. 8, 1895*
Civil Engineer, New London, Conn.

DARROW, COURTLAND R. .... Jan. 8, 1895
Civil Engineer, New London, Conn.

DAVIS, ARTHUR L. .... July 18, 1899
Assistant Manager Eastern District and Export, American Bridge Co.,
100 Broadway, New York.

DAVIS, F. IRWIN .... Oct. 11, 1902
Architect, Hartford, Conn.

DePEYSTER, FREDERICK .... Sept. 3, 1891
Byxbee-DePeyster Trap Rock Co., Meriden, Conn.

DEYO, SOLOMON LeF. .... Jan. 9, 1900
Chief Engineer New York Rapid Transit Subway Construction Co.,
New York City, N. Y.

DuBOIS, AUGUSTUS J. .... Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School, Yale University,
New Haven, Conn.

DUNCAN, EDGAR T. .... Feb. 14, 1905
Civil Engineer, Bloomfield, Conn.

EASTERBROOK, FREDERICK J. .... March 30, 1900
Assistant Engineer N. Y., N. H. & H. R. R. Co., New Haven, Conn.

EDDY, CHARLES W. .... Jan. 9, 1900
Civil Engineer, Waterbury, Conn.

ELLSWORTH, FREDERICK H. .... March 30, 1900
Division Engineer N. Y., N. H. & H. R. R. Co., New Haven, Conn.

EVERIT, EDW. H. .... Oct. 11, 1902
Engineer S. N. E. Telephone Co., New Haven, Conn.

FARNHAM, CHARLES S. .... Feb. 9, 1904
Civil Engineer, Hartford, Conn.

FERRY, CHARLES A. .... Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

FORBES, HENRY DeB. .... April 20, 1901
Civil Engineer, West Haven, Conn.

FORD, FREDERICK L. .... Jan. 12, 1897
City Engineer, Hartford, Conn.

FORD, THEODORE B. .... April 20, 1901
Civil Engineer, Bridgeport, Conn.

FULLER, AUBREY D. ....Feb. 10, 1903
Civil Engineer, New Haven, Conn.

FULTON, WILL H. ....Jan. 8, 1901
City Engineer's Office, New Haven, Conn.

GAGEL, EDWARD ....Jan. 9, 190[illegible]
Dis't Engineer N. Y., N. H. & H. R. R. Co., West Haven, Conn.

GALLUP, CHRISTOPHER M. ....Jan. 10, 1869
Hartford, Conn.

GILLETTE, GEORGE W. F. ....Jan. 9, 1900
G. M. Grant Co., New Haven, Conn.

GLADDING, HENRY H. ....Jan. 9, 1900
Assistant City Engineer, New Haven, Conn.

GIBBS, EDWARD O. ....Nov. 29, 1890
Assistant Treasurer Scovil Mfg. Co., Waterbury, Conn.

GRAVES, EDWIN D. ....Oct. 25, 1895
Chief Engineer Conn. River Bridge and Highway District,
Hartford, Conn.

GRAVES, HENRY S. ....Feb. 14, 1905
Associate Member, Prof. of Forestry, Yale University, New Haven, Conn.

GREENWOOD, ALBERT H. ....Feb. 9, 1904
With Berlin Construction Co., Berlin, Conn.

GREGORY, J. LOUIS ....Aug. 10, 1904
Civil Engineer, Greenwich, Conn.

HALE, PERRY [illegible] W. ....Feb. 10, 1903
Civil Engineer, Portland, Conn.

HALL, A. CLARK ....Jan. 8, 19[illegible]
[illegible] Water Department, West Hartford, Conn.

HAMILTON, MORRISON C. ....Jan. 9, 1900
[illegible] Rapid Transit Co.,
New York [illegible]

[illegible] ....Aug. [illegible] 1904
[illegible] N. Y., N. H. & H. R. R.
New Haven, Conn.

[illegible] ....Feb. [illegible]
[illegible] Conn.

[illegible] ....Feb. [illegible]
[illegible] New Haven, Conn.

[illegible] ....Feb. [illegible]
[illegible] Conn.

[illegible] ....Feb. [illegible]
[illegible]

[illegible] ....[illegible]
[illegible] Hartford, Conn.

[illegible] ....[illegible]
[illegible] R. R., New Haven, Conn.

[illegible] ....Jan. [illegible]
[illegible] New Haven, Conn.

[illegible] ....[illegible]
[illegible]

[illegible] ....[illegible]
[illegible] Hartford, Conn.

[illegible] ....[illegible]
Civil Engineer [illegible] Conn.

ROBERT S. HULBERT........April, 1884
Civil Engineer. West Winsted, Conn.

INGERSOLL, C. M., JR. ....Jan. 8, 1901
Chief Engineer N. Y., N. H. & H. R. R., New Haven, Conn.

INGRAHAM, EDWARD R. ....Feb. 9, 1904
General Agent Conn. Mutual Life Ins. Co., New Haven, Conn.

JACKSON, J. FREDERICK ....Jan. 9, 1900
Civil Engineer, New Haven, Conn.

JAMESON, MINOR S. ....Feb. 9, 1904
Civil Engineer, Bridgeport, Conn.

JARVIS, CHARLES M. ....April, 1884
Vice President P. & F. Corbin Co., New Britain, Conn.

JAYNES, FRANK B. ....Feb. 10, 1903
Civil Engineer, Bridgeport, Conn.

JESSUP, JOHN C., JR. ....Feb. 9, 1904
Civil Engineer, Brooklyn, N. Y.

JOHNSON, WILLIAM D. ....Aug. 14, 1900
Architect, Hartford, Conn.

JOHNSON, WILLIAM E. ....Nov. 29, 1890
Engineer of Hartford Water Works, West Hartford, Conn.

JONES, EDWIN J. ....Feb. 9, 1904
Civil Engineer, Hartford, Conn.

JONES, WALTER A. ....Feb. 10, 1903
Civil Engineer, New Haven, Conn.

KEHR, HARRY T. ....Aug. 10, 1904
Civil Engineer, New Haven, Conn.

KEITH, HERBERT C. ....Jan. 9, 1900
Consulting Engineer, Hanover Bank Building, New York City.

KELLOGG, HENRY J. ....April, 1884
First Assistant City Engineer, New Haven, Conn.

KELLY, CASSIUS W. ....Jan. 9, 1900
City Engineer, New Haven, Conn.

KIRBY, RICHARD S. ....March 30, 1900
Civil Engineer, Port Chester, N. Y.

KITCHEN, FRANK H. ....Jan. 8, 1901
With Hartford Street Railway Co., Hartford, Conn.

KNIGHT, HERBERT M. ....Jan. 9, 1900
Construction Engineer of the Continental Compressed Air Co.,
Norwich, Conn.

LAFORGE, FREDERICK W. ....Jan. 13, 1885
U. S. Engineer, Fort Terry, Plum Island, N. Y.

LANE, JOHN S. ....Jan. 8, 1901
John S. Lane & Sons, Meriden, Conn.

LANE, E. LEROY ....Jan. 8, 1901
Contractor, Hingham, Mass.

LAW, ARTHUR P. ....Feb. 9, 1904
Civil Engineer, Bridgeport, Conn.

LAW, WALTER H. ....Aug. 10, 1904
Civil Engineer, Bridgeport, Conn.

LAWTON, EDWIN F. ....March 30, 1900
Superintendent Hartford Electric Light Co., Hartford, Conn.

LEACH, SMITH S. ....Jan. 8, 1901
Major Engineers, U. S. Government, Fort Leavenworth, Kansas.

LEE, EDWIN M. .... Feb. 10, 1903
Civil Engineer, Gardner, Mass.

LEWIS, ROBERT P. .... Oct. 24, 1895
Secretary Blake & Johnson, Waterbury, Conn.

LOOMIS, FRANK W. .... July 18, 1899
Civil Engineer and Surveyor, Hartford, Conn.

LUTHER, FLAVEL S., JR. .... Feb. 9, 1904
President Trinity College, Hartford, Conn.

MACMAHON, ROBERT Q. .... Feb. 10, 1903
Civil Engineer, New London, Conn.

MALONEY, DENNIS J. .... April 20, 1901
Superintendent of Buildings, Board of Education, New Haven, Conn.

MALONEY, FRANK A. .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

MANNING, GEORGE E. .... Jan. 11, 1898
Civil Engineer, New London, Conn.

MARCHANT, ORSON H. .... Feb. 14, 1905
Civil Engineer, New Haven, Conn.

McKENZIE, J. M. .... April, 1884
Civil Engineer and Surveyor, Yalesville, Conn.

McKENZIE, THEODORE H. .... April, 1888
Sanitary and Hydraulic Engineer, Southington, Conn.

McKNIGHT, JOHN T. .... May 31, 1893
City Engineer, Rockville. Residence, Ellington, Conn.

McLEAN, GEORGE S. .... Feb. 9, 1904
Civil Engineer, Bristol, Conn.

[illegible], CHARLES H. .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

[illegible] .... Aug. 22, 1901
Civil Engineer, U. S. Fortification, Fisher's Island, N. Y.

[illegible] .... Feb. 9, 1904
[illegible] Engineer, New Haven, Conn.

[illegible] .... Sept. 25, 1886
[illegible] Engineer, [illegible], Conn.

[illegible] .... Jan. [illegible]
[illegible] Engineer and Surveyor, [illegible], Conn.

[illegible] .... Jan. [illegible]
[illegible] R. R., New Haven, Conn.

[illegible] .... Aug. [illegible]
[illegible] Engineer, Hartford, Conn.

[illegible] .... April [illegible]
[illegible] Engineer, [illegible], Conn.

[illegible] .... Feb. [illegible]
[illegible] Engineer, [illegible], Mass.

[illegible] .... [illegible]
[illegible] Engineer, [illegible], Hartford, Conn.

[illegible] .... Aug. [illegible]
[illegible] Engineer, [illegible] R. R., New Haven, Conn.

[illegible] .... Jan. [illegible]
[illegible] Engineer and Surveyor, [illegible], Conn.

[illegible] .... Jan. [illegible]
[illegible] Engineer and [illegible] Commission,
New Haven, Conn.

NICHOLS, CLARENCE H. .... Feb. 9, 1904
Civil Engineer, Danielson, Conn.

NOBLE, EDWARD J. .... Jan. 8, 1901
Hartford, Conn.

O'CONNOR, DON, Associate Member .... Feb. 9, 1904
D. F. Keenan, Hartford, Conn.

OLDERSHAW, FRANCIS H. .... Jan. 8, 1901
City Engineer, New Britain, Conn.

OLMSTED, C. HENRY .... July 18, 1899
Civil Engineer and Surveyor, East Hartford, Conn.

OSBORNE, FRED. H. .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

OWEN, ELIJAH H. .... March 30, 1900
Civil Engineer, Brooklyn, N. Y.

PALMER, GEORGE E. .... March 30, 1900
Assistant Engineer N. Y., N. H. & H. R. R., West Haven, Conn.

PALMER, SHEPARD B. .... Jan. 8, 1895
Civil Engineer and Surveyor, Norwich, Conn.

PALMER, WILLIAM B. .... Jan. 13, 1885
Civil Engineer and Surveyor, Bridgeport, Conn.

PARDEE, WILLIAM S., Associate Member .... Aug. 10, 1904
Wright & Pardee, New Haven, Conn.

PARKER, GEORGE A. .... July 18, 1899
Superintendent of Keney Park, Hartford, Conn.

PARSONS, FRED H. .... Oct. 11, 1902
Sup't Mulloy, Rexford & Co., Williamsbridge, N. Y.

PARSONS, HAROLD A. .... Aug. 14, 1900
Civil Engineer, Stamford, Conn.

PATTON, ARTHUR J. .... Sept. 12, 1889
Land Surveyor, Waterbury, Conn.

PECK, ERMON M. .... Jan. 8, 1895
Assistant Engineer Hartford Water Works, West Hartford, Conn.

PECK, LEON F. .... Oct. 11, 1902
Civil Engineer, Greenwich, Conn.

PENDLETON, CLAUDIUS V. .... Aug. 10, 1904
Civil Engineer, Yantic, Conn.

PENFIELD, GEORGE W. .... Jan. 8, 1901
Civil Engineer, New Britain, Conn.

PHELPS, JAMES W. .... Oct. 11, 1902
Civil Engineer, Hartford, Conn.

PIERCE, WILLIAM B. .... Feb. 9, 1904
Civil Engineer, Stamford, Conn.

PIERSON, STEPHEN C. .... Jan. 13, 1885
Civil Engineer and Surveyor, Meriden, Conn.

PIKE, ROBERT G. .... Jan. 8, 1901
Street Commissioner, Middletown, Conn.

PIKE, WILLIAM K. .... Feb. 9, 1904
Civil Engineer, Danielson, Conn.

POWELL, MAJOR CHARLES F. .... Feb. 10, 1903
U. S. Engineer, New London, Conn.

PUNDERFORD, JOHN K. .... Jan. 9, 1900
Gen. Manager, Consolidated Railway Co., New Haven, Conn.

REYNOLDS, WM. B. .... Aug. 14, 1900
Land Surveyor, Waterbury, Conn.

RICE, ARTHUR W. .... April, 1884
President Union Mfg. Co., New Britain, Conn.

RICHARDS, WALTER H. .... March 30, 190[illegible]
Engineer of Water and Sewer Departments, New London, Conn.

RIGHTS, LEWIS D. .... Aug. 10, 1904
Civil Engineer, New Haven, Conn.

ROBINSON, HALBERT G. .... Jan. 11, 1898
Civil Engineer and Surveyor, Patten, Maine.

ROBINSON, LEONI W. .... Feb. 14, 1905
Architect, New Haven, Conn.

ROBINSON, SEYMOUR N. .... Feb. 5, 1904
Civil Engineer, Hartford, Conn.

ROLLINS, ROBERT W. .... Jan. 5, 1901
General Manager Hartford Electric Light Co., Hartford, Conn.

RUNGE, EDWARD [illegible] .... Jan. 8, 1901
Civil Engineer, New Haven, Conn.

RYDER, ELY M. T. .... Jan. 5, 1906
Instructor Yale University, New Haven, Conn.

SAGE, GEORGE E. .... Jan. 8, 1895
Vice President Berlin Construction Co., Berlin, Conn.

SELLECK, PHILIP .... Feb. 3, 1904
Civil Engineer, [illegible], Conn.

SHAUGHNESSY, [illegible] F. .... Feb. 11, 1902
Board of Water Commission, Hartford, Conn.

SLADE, RICHARD [illegible] .... Aug. 11, 1904
Hartford Gas Light Co., Hartford, Conn.

SMITH, GEORGE [illegible] .... Feb. 11, 1903
Assistant City Engineer, Derby, Conn.

SMITH, [illegible] .... March 31, 1900
[illegible], Hartford, Conn.

SMITH, [illegible] .... April, 1884
[illegible], Waterbury, Conn.

[illegible] .... Jan. 8, 1901
[illegible]

[illegible] .... June 18, 1889
[illegible] Street Railway Co., Hartford, Conn.

[illegible] .... Aug. [illegible], 1904
[illegible] R. R., Bridgeport, Conn.

[illegible] .... Aug. 11, 1904
[illegible] R. R., New Haven, Conn.

[illegible] .... Jan. 8, 1901
[illegible], Hartford, Conn.

[illegible] .... Jan. 1, 1900
[illegible] R. R., New Haven, Conn.

[illegible] .... Jan. 1, 1900
[illegible], New Haven, Conn.

[illegible] .... Feb. 3, 1904
[illegible], Conn.

[illegible] .... Dec. 11, 1902
[illegible], Conn.

[illegible] .... Dec. 11, 1902
[illegible], N. Y.

STERLING, [illegible] .... Dec. 11, 1902
[illegible], Bridgeport, Conn.

STODDARD, RAYMOND FRENCH .... Jan. 9, 1900
Civil Engineer, N. Y., N. H. & H. R. R., Bridgeport, Conn.

STONE, EDWARD M. .... July 18, 1899
With H. A. Wolcott, Hartford, Conn.

SULLIVAN, JOHN M. .... Aug. 10, 1904
Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

TAYLOR, LUCIAN A. .... June, 1887
Civil Engineer and Contractor, Boston, Mass.

TAYLOR, WILLIAM T. .... Feb. 9, 1904
Civil Engineer, Hartford, Conn.

TERRY, ALFRED H. .... Feb. 11, 1900
Division Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

THOMAS, JAMES B. .... Jan. 9, 1900
Civil Engineer and Surveyor, Hartford, Conn.

TRACY, JOHN C. .... Jan. 9, 1900
Assistant Professor of Structural Engineering, Yale University, New Haven, Conn.

TRUESDELL, WALTER E. .... June 11, 1898
Civil Engineer, Norwalk, Conn.

TRUMBULL, JOHN F. .... Aug. 10, 1904
Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

TURNER, ALBERT M. .... Aug. 10, 1905
Civil Engineer, New Haven, Conn.

UNKELBACH, MAX J. .... Jan. 9, 1900
Architect and Civil Engineer, New Britain, Conn.

VERRILL, GEORGE E. .... Feb. 11, 1902
U. S. Assistant Engineer, New Haven, Conn.

VORCE, CLARENCE B. .... Jan. 10, 1899
John F. Kelly Engineering Co., New York City.

WADHAMS, JOSEPH P. .... Feb. 9, 1904
Civil Engineer, Torrington, Conn.

WADSWORTH, A. R. .... Oct. 27, 1886
Civil Engineer and Surveyor, Farmington, Conn.

WARD, EDWARD T. .... Jan. 9, 1900
Consulting Engineer, Bridgeport, Conn.

WARDWELL, FREDERICK S. .... Feb. 9, 1904
Civil Engineer, Stamford, Conn.

WASHBURN, ALBERT L. .... Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

WEAVER, HALSEY A. .... Jan. 12, 1897
Civil Engineer, Clinton, Conn.

WELTON, NELSON J. .... April, 1884
Civil and Hydraulic Engineer, Waterbury, Conn.

WEST, MYRON H. .... Feb. 9, 1904
Civil Engineer, Hartford, Conn.

WHEELER, CHAS. A. .... Jan. 8, 1901
Prof. of Mathematics, Conn. Agricultural College, Storrs, Conn.

WHEELER, FREDERICK I. .... Aug. 27, 1901
U. S. Engineer's Office, New London, Conn.

WHITE, HOWARD E. .... Feb. 9, 1904
New Haven Gas Light Co., New Haven, Conn.

WHITNEY, ELI .... March 30, 1900
President New Haven Water Co., New Haven, Conn.

WHITON, FRANK W. .... Feb. 14, 1905
Associate Member. Architect, Hartford, Conn.

WIGGIN, ERNEST W. .... March 30, 1900
Second Assistant Bridge Engineer, N. Y., N. H. & H. R. R.,
New Haven, Conn.

WILCOX, RALPH M. .... Jan. 8, 1901
City Engineer, Middletown, Conn.

WILKES, J. K. .... April, 1884
City Engineer, New Rochelle, New York.

WIRTH, THEODORE .... July 18, 1899
Superintendent Public Parks, Hartford, Conn.

WOLCOTT, HENRY A. .... July 18, 1899
Mechanical and Civil Engineer, Hartford, Conn.

WOOD, CHAS. N. .... Aug. 14, 1900
Civil Engineer, Norwalk, Conn.

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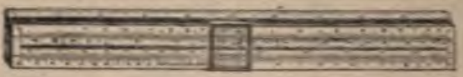

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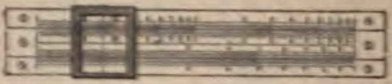

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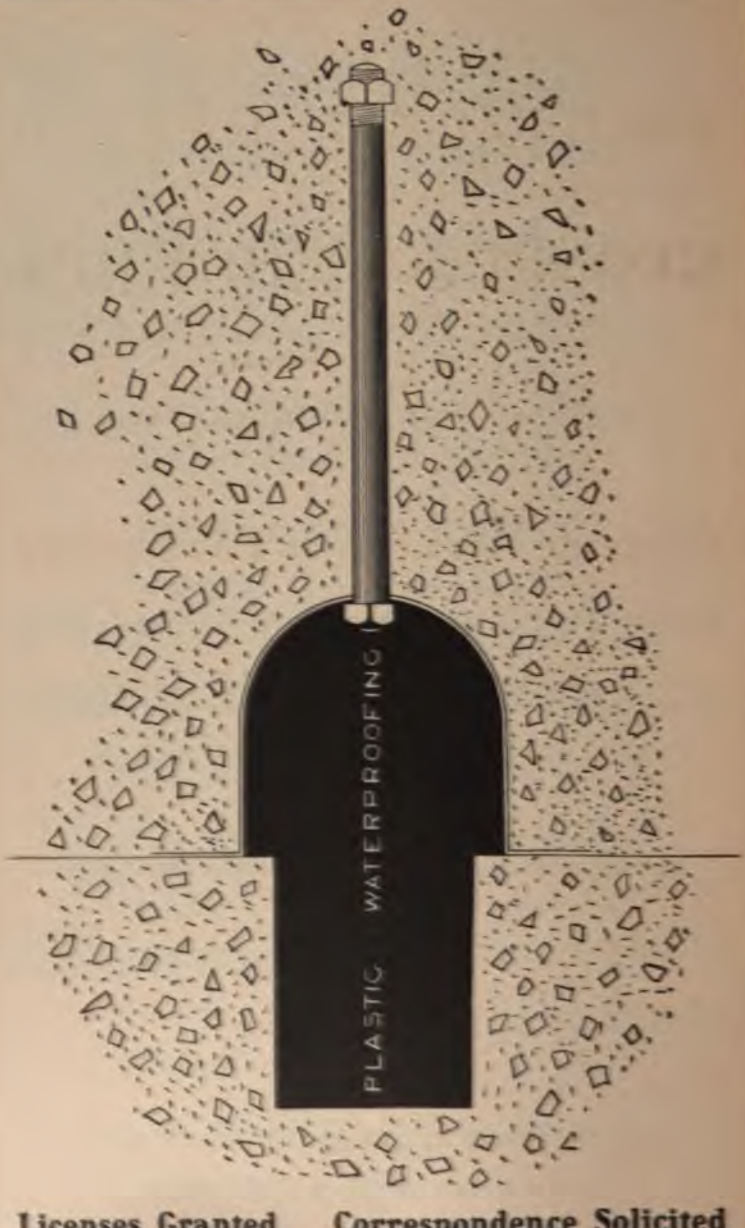

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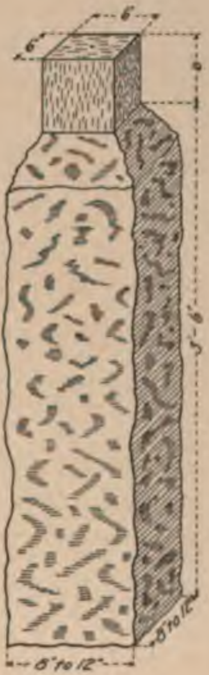

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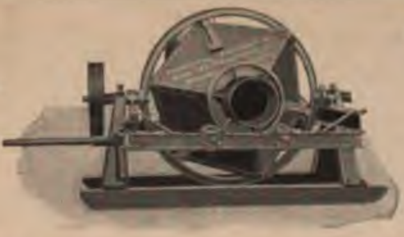

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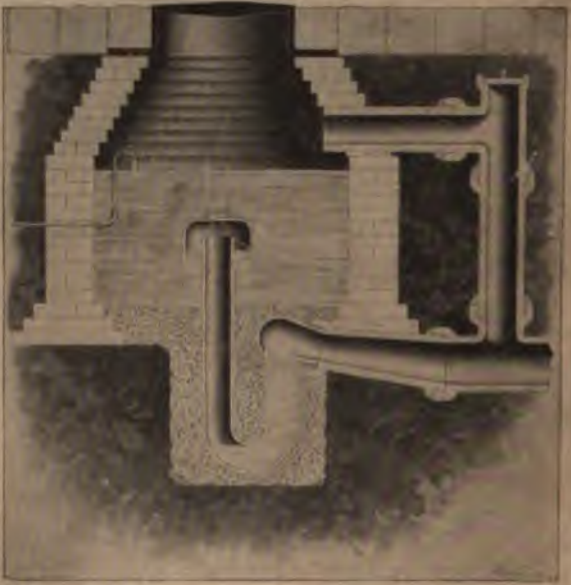

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